

SCIENCE ABSTRACTS.

Section A.—PHYSICS.

JANUARY 1910.

GENERAL PHYSICS.

1. *Machine for Mechanical Testing of Indiarubber.* C. Beadle and H. P. Stevens. (Soc. Chem. Ind., Journ. 28, pp. 1111-1112, Nov. 15, 1909.)—Test pieces are cut from sheets 1 mm. thick, in the form of rings 10 mm. diam. with a 5-mm. hole in the centre, and are attached to two iron hooks, one fastened to a stationary block and the other to a sliding block moving horizontally on the base of the machine. A cord passing over a pulley and carrying a light metal bucket is attached to the sliding block. Tension is applied by running water into the vessel at the constant rate of 1,000 gm. per min., and when the test-ring breaks the water supply is cut off automatically. Elongation is measured by means of a pointer attached to the sliding block and moving over a scale. When rupture occurs the hook falls and releases the indicator, which remains at the point of total elongation. If desired, a light Al pan can be substituted for the bucket, and the loading effected by means of weights. F. C. A. H. L.

2. *New Form of Sensitive Barometer.* J. Carpentier. (Comptes Rendus, 149, pp. 1028-1080, Dec. 6, 1909.)—The instruments exhibited by the author were made by de Montrichard. The changes in volume of an imprisoned mass of air are indicated by an index moving in a very narrow tube. The novelty of the apparatus consists in the method adopted for eliminating temperature effects. This is achieved by enclosing the air in a double-walled, exhausted vessel similar to those used for storing liquid air. By placing a few gm. of melting ice in the vessel the temperature can be kept at the freezing-point for a very long time. R. G. K. L.

3. *Secular Softening of Glass-hard Steel.* L. C. Brant. (Phys. Rev. 29, pp. 485-488, Nov., 1909.)—A measurement of the electrical resistance and thermoelectric quality of about twenty glass-hard Stubb's steel rods which had been measured by Barus in June, 1885, a few days after tempering, and at certain intervals thereafter. From the change in specific resistance it is inferred that the rods have softened to the extent of losing nearly 20 per cent. of the original specific resistance. The total decrement from glass-hard to

soft steel being reckoned at from 60 to 70 per cent., the rods should become soft in about 200 years at the soonest, but more probably in a much longer time.

G. E. A.

4. *Clock Screws*. M. Picard. (Bull. Soc. d'Encouragement, 112. pp. 866-876, Aug.-Sept.-Oct., 1909.)—A commission appointed by the above Society on this subject gives its sanction to the report (slightly amended) by M. Picard as below: The diam. of screw dealt with ranges from 7/10 mm. to 25/10 mm., the corresponding pitches ranging from 17/100 mm. to 44/100 mm. Clockmakers at present use several different gauge systems. The present is an attempt to provide unification in this class of screw. Of previous systems that of Thury, called *Série Thury*, or *Série Suisse*, has been prominent. It was accepted by the British Association (1884), and with slight modifications by the Berlin Reichsanstalt (1898). But in practice this system was found unsuccessful, partly from the fact that dimensions were not in all cases easily expressible in fractions of a millimetre. Of other series proposed there are four prominent ones. The series now suggested is called the *Série Internationale*. It adopts (1) the simple rules suggested in the (theoretical) metric series. These rules concern the numbering of screws and the relation of pitch to diam. (2) The diams. of the small screws increase by steps of 1/20 mm. for small and by 1/10 mm. for larger screws, and (3) the same pitch is used for two consecutive screws so as to facilitate replacement of screws in apparatus.

P. E. S.

5. *Bifilar Pendulum*. H. Pellat. (Comptes Rendus, 149. pp. 778-775, Nov. 8, and p. 980, Nov. 29, 1909.)—A weight, preferably a hollow ring, is suspended by two parallel very fine ribbons, preferably of invar. The greatest dimension of the ribbon is perpendicular to the plane P containing them. The suspended system is set oscillating so that the centre of gravity remains in plane P. The length of the threads in this bifilar system is that of the synchronous simple pendulum. The formula arrived at is—

$$T = 2\pi[(l - \lambda)(1 + \mu/M)/g]^{1/2}(1 + A),$$

where A is the usual series in $\sin(\alpha/2)$ for amplitude; l is the length of either ribbon; M is the suspended mass; and μ is a term involving buoyancy, weight of ribbons, hydrodynamic increment in M due to air inertia and elasticity of ribbons. This complicated term μ is eliminated by taking two times of vibration: (1) When the suspended ring contains mercury, and (2) when the ring is empty. The method is considered capable of precision in the determination of g , whilst being more simple and less costly than the reversible pendulum. The correction (λ) for stiffness of the suspending strips to be applied is the simple reduction in the length of the strip by a small length which is independent of the length of the strip and of the amplitude. For the thinnest strips obtainable this correction is only about 1/8000 of the length of the strip.

P. E. S.

6. *Dimensions*. P. Juppont. (Soc. Int. Élect., Bull. 9. pp. 529-551, Aug.-Sept.-Oct., 1909.)—The author, after discussing the dimensional equations of electrical quantities, is led to abandon the Galilean definition of force = Ma and the corresponding constancy of mass, and to make a fresh start from Kepler's laws, $L^2 = bT^2$ and $L^2 = b'T$ (law of areas), which would be satisfied if $b = M$, that is $M = L^2/T^2$; and then b' , a constant variable with

each planet, is a specific measure of matter $= q$; then $M/q = L/T = V$. From this he deduces a series of simplifications; the dimensions all run in whole numbers of L and T ; many analogies are unfolded; the action of the medium comes into the equations; the present system of units belongs to the mechanics in a vacuum; thermic quantities fall into line; and Clausius' principle of entropy takes the form that the actual energy of the universe tends to pass from the ether to the gravific mass. Incidentally, the author points out some reforms required in the current terminology, and advocates the division of the quarter day into 10,000 biseconds, each $= 2.16$ sec., with corresponding units of linear and angular velocity. In the discussion (*Ibid.* pp. 558-568), E. Brylinski acutely criticises the author's suggestions; he had himself been fascinated twenty years ago by the potentialities of the expression $M = L^2/T^2$, but had abandoned these; L and T must remain as fundamental concepts, but they cannot stand alone without introducing danger of deceptive reasoning; but if we were now to choose the third basis, it would probably be better to choose energy rather than mass. A. D.

7. *Mechanical Units.* J. Lavaux. (*Journ. de Physique*, 8, pp. 849-858, Nov., 1909.)—The Congrès de Mécanique of 1889 adopted the weight of 1 kg. as the unit of force. The Conférence générale des Poids et Mesures, 1901, adopted the kg. as a unit of mass, and refused to admit the kg.-weight even as a secondary unit of force. It adopted the value $g = 980.665$. Under these circumstances Guillaume has proposed to adopt, under the name of "megadyne," that force which will give 1 kg.-mass an acceleration of 10 m./sec.². The author proposes to adopt this acceleration as the normal; it would be the acceleration due to gravitation at a depth of about 180 km., and also at a depth of about 2000 km. below the earth's surface. The unit of mass would then be 10 kg. The results would be right within 2 per cent.; and if required the ratio 980/1000 could be introduced. The horse-power might well give place to the kilowatt. A. D.

8. *Fluid Pressure on Inclined Planes.* A. Rateau. (*Engineering*, 88, pp. 886-887, Sept. 17, 1909. Paper read before the Assoc. Technique Maritime, 1909.)—Rateau's experiments shed some light on Lanchester's conclusion that the surface friction of a plate is 0.02 times as great as the pressure on the plate would be were it placed normal to the air current, whereas Zahn's and other experiments on surface friction show that the coefficient is about one-tenth of the above value. A partial reconciliation of the two views is afforded by Rateau's discovery that the resultant pressure is, in general, not normal to the plane, the variation differing with the angle of inclination. For planes inclined at 10° to the air current the deviation of the resultant from the normal is 1° , which would correspond to a coefficient of 0.017, instead of the 0.02 adopted by Lanchester. Rateau's treatment of this "fictitious" friction is based upon his theory of the screw propeller. E. E. F.

9. *Flapping Flight.* M. F. FitzGerald. (*Roy. Soc., Proc. Ser. A*, 88, pp. 72-78, Nov. 8, 1909.)—The resistance opposed to the acceleration of a body immersed in a liquid may be represented by a virtual addition to its mass, without any corresponding addition to its weight. A wing flapping in air may shed, or escape from, the virtual added mass at will, much as the paddle of a Canadian canoe can slip out of the disturbance it has created during a stroke. Hence a heavy body or engine attached to a wing should

be capable of supporting itself and the wing in the air in a succession of leaps. For if the whole be supposed initially falling, a sufficiently energetic pull given by the engine, drawing the wing down and itself up, could convert the fall of their common centre of gravity into a rise, if there were a weightless but massive body temporarily attached to the wing. If, when this rise had been started, the added mass were shed or escaped from, there would be an interval in which the centre of gravity of the whole would continue to rise, during which the wing and body could be replaced in their original relative positions by mutual action between them, wholly internal to their system, free except for gravity. If at the end of the rise added mass were again picked up, the same might fall to its initial level and velocity. The process thus becomes cyclic, and may be indefinitely repeated. The author calculates the power required to carry 1 lb. in the case of a "wing" in the shape of a flat circular disc 12 ft. in diam., for various values of the ratio of the additional virtual mass to the weight. The weight carried per h.p. is a linear function of A , and amounts to 84 lbs. per h.p. when $A = 1$. It varies directly as the rate of flapping.

E. E. F.

10. *Models of Airships and Flying Machines.* L. Prandtl. (Zeitschr. Vereines Deutsch. Ing. 53. pp. 1711-1719, Oct. 16, 1909.)—Describes the Airship Model Experimental Institute at Göttingen, just established by the Berlin Motorluftschiff-Studiengesellschaft. The work undertaken there concerns itself with airships and flying machines. The results obtained can be transferred from models to large-scale machines by considering that the forces in play vary as the surfaces and as the squares of the velocities. This rule neglects skin friction. The compressibility of the air plays practically no part, since at the usual speeds (below 100 m./sec.) air behaves as an incompressible fluid. The variation of speed is studied in the model experiments by fixing the model in a tunnel through which is blown a uniform air-blast of known speed, which can be altered in the ratio 1 : 4, thus giving forces varying in the ratio 1 : 16.

E. E. F.

11. *Viscosities of certain Gases and Gaseous Mixtures at different Temperatures.* K. Schmitt. (Ann. d. Physik, 80. 2. pp. 398-410, Oct. 14, 1909.)—The author has measured by the transpiration method the viscosity of air, helium, hydrogen, argon, nitrogen, and oxygen, and of binary mixtures of these gases, at temperatures ranging from about $+185^{\circ}$ to -195° , the apparatus used by Schultze [Abstract No. 1616 (1901)] being employed. By means of Sutherland's formula (Phil. Mag. 5. 86. p. 507, 1898)—

$$\eta = \eta_0 (1 + aC) \sqrt{1 + a\delta} / (1 + C/\theta),$$

where δ is the temperature in deg. Cent., θ the absolute temperature, and C a measure of the cohesion of the gaseous medium, the following values of C and η_0 have been calculated from the results obtained :—

	C.	$\eta_0 \times 10^6$		C.	$\eta_0 \times 10^6$
He	78.2	1887	N (atmospheric) ..	115	1675
Ar	174.6	2114	N (chemical) ...	118	1674
H	88	841	O	188	1926

Within wide limits, the above formula gives concordant results for the viscosity of air, hydrogen, oxygen, nitrogen, argon, and helium; with argon,

helium, and hydrogen at the temperature of liquid air differences appear which indicate greater viscosities than are given by the formula. The viscosity coefficient of hydrogen is increased considerably by a small admixture of oxygen or nitrogen, whilst the viscosities of these two gases are only slightly influenced by the presence of small proportions of hydrogen. Sutherland's formula expresses satisfactorily the viscosities of mixtures of argon and helium and of binary mixtures of hydrogen, oxygen, and nitrogen. Thiesen's formula for the viscosity of gaseous mixtures [Abstract No. 616 (1908)] agrees with the observed values better than that of Pöluj (1879). Thiesen's assumption of so-called diffusion-constants is not confirmed by the observations on the mixtures Ar-He, H-O, N-O, and H-N. T. H. P.

12. *Composition of Velocities in Relativity Theory.* A. Sommerfeld. (Phys. Zeitschr. 10. pp. 826-829, Nov. 10, 1909. Paper read before the Versamml. Deutsch. Naturforscher u. Ärzte, Salzburg, Sept. 21, 1909.)—Minkowski has taught us to regard the Lorentz-Einstein transformation as a space-time rotation, i.e., as a transformation of the character of an ordinary turning, but not in the space x, y, z , but in the four-dimensional manifoldness (Mannigfaltigkeit) of the quantities x, y, z, t , where $t = ict$, or the light-path multiplied by the imaginary unit i . The subject of the vector addition of quantities is then developed on this basis and illustrated by figures denoting a quasi-spherical trigonometry in which imaginary quantities enter. The object of the article is to show that the profound space-time conception due to Minkowski not only simplifies the systematic treatment of the general theory of relativity, but is also a most convenient guide in dealing with special problems. E. H. B.

13. *Uniform Rotation of Rigid Bodies and Theory of Relativity.* P. Ehrenfest. (Phys. Zeitschr. 10. p. 918, Nov. 22, 1909.)—If one endeavours to generalise the kinematics of rigid bodies on the relativity theory by passing from the case of uniform translations to any motions whatever, then difficulties are soon met with even in very simple cases. Thus, if a cylindrical body of radius R is rotating uniformly about its axis which is fixed, then since each part of the periphery is moving *endwise* it should contract to one of a radius R' say, where $2\pi R' < 2\pi R$. But, on the other hand, since such radius is moving *perpendicularly* to itself, there should be no contraction of the radius, or $R' = R$. Hence, the consideration of periphery and radius lead to conflicting results. [See also Abstract No. 1728 (1909).] E. H. B.

14. *Sunshine at Helsingfors.* A. V. Johansson. (Öfversigt af Finska Vetenskaps-Societeten's Förhandl., 1907-1908, No. 18. Abstract by J. Hann, Meteorolog. Zeitschr. 26. pp. 521-522, Nov., 1909.)—The Campbell-Stokes recorder did not record for 0.7 hour at sunrise and for 0.8 hour at sunset—a total of 1.5 hour against 1.1 hour at Greenwich and 0.5 at Tiflis. Helsingfors receives 11.0 per cent. of the possible sunshine in winter and 49.2 in summer, 35 per cent. in the mean, 67 per cent. about noon in June and July. The maximum is generally in the afternoon; the duration is 9.4 hours in July, 0.5 hour in Dec. Sunshine records and serenity figures (100 minus the cloudiness) agree in May and Oct.; in winter the sunshine records are far smaller than the figures derived from estimates of the cloudiness. The relations between duration of sunshine and cloudiness are further discussed. H. B.

15. *Mountain and Valley Winds in the Tyrol.* A. Defant. (Akad. Wiss. Wien, Sitz. Ber. 118, 2a, pp. 558-604, May, 1909. K.K. Zentralanstalt für Meteorologie u. Geodynamik.)—The phenomenon of the diurnal variation of mountain and valley winds is strongly developed in the long and narrow valleys of the Southern Tyrol, which give upon the plain of the Po. The data for the diurnal variation of the barometer at Milan, Modena, and Vicenza are combined to give a generalised value for the variation in the Po valley at altitude 62 m. which may be represented by the harmonic terms $0.270 \sin(9.15 + x) + 0.358 \sin(142 + 2x)$, pressure being measured in mm. of mercury. At Bozen (292 m., 150 km. up the narrow valley of the Etsch) the diurnal variation of pressure is represented by $0.958 \sin(18.1 + x) + 0.439 \sin(152.8 + 2x)$. From these data the diurnal variation of pressure-difference Bozen-Po valley, at the altitude 292 m. is calculated. It may be represented by $0.878 \sin(23.2 + x) + 0.152 \sin(198.8 + 2x)$, from which it appears that the diurnal variation is very large compared with the semi-diurnal. The gradient is zero at about 10 a.m. and 10 p.m., it is directed towards the south during the forenoon and towards the north during the afternoon. These results are compared with wind observations at Riva at the northern extremity of Lake Garda. Here the Ora, or south wind, sets in with remarkable suddenness on all fine days. The mean time of onset is 11 a.m. in summer, about an hour after the occurrence of the zero pressure gradient between Bozen and the Po valley. The greatest wind velocity is attained normally about 2 p.m.; the south wind ceases in summer between 8 and 9 p.m. and gives place to northerly winds during the night and early morning. In winter the Ora begins later and ceases earlier. The observed winds are thus dependent on the pressure gradient along the valley of the Etsch. The second part of the paper is devoted to a discussion of the results in the light of Hann's theory of mountain and valley winds. The observed gradient along the valley is found to be considerably in excess of the gradient calculated from the available data of the diurnal variation of temperature at Bozen and the plain of the Po, according to the theory of the lifting of the isobaric surface. The large decrease of pressure at Bozen in the afternoon, which finds expression in the harmonic analysis in the unusually large first-order term, is explained by the flow of air out of the valley, up the mountain slopes in a direction transverse to that of the valley. An approximate calculation of the magnitude of this flow gives results of the required order. The third section of the paper is devoted to a discussion of the wind observations made at 7 a.m., 2 p.m., and 9 p.m. at stations of the second order in the region under consideration. They are found to be in close agreement with theory.

R. G. K. L.

16. *Meteorology of Samoa, 1902 to 1906.* III. *Sunshine.* O. Tetens. (Monthly Weather Rev., Washington, 37, pp. 240-241, June, 1909.)—The Campbell-Stokes recorder failed to record for about an hour each day. The last two months of the dry season, Sept. and Oct., received most sunshine, about 60 per cent. of the possible; in the other months the distribution is irregular. The average number of clear days is the same in the wet and the dry seasons; overcast days without sunshine represent 7 per cent. of the year. In the dry season the sunshine predominates in the evening hours; during the wet months the higher altitude of the sun between 7 and 8 a.m. helps the sun to overcome the absorption produced by the lower strata [compare Abstract No. 1995 (1909)].

H. B.

17. *Seasonal Variation of Thunderstorms in Hungary.* E. Héjas. (Meteorolog. Zeitschr. 26. pp. 501-507, Nov., 1909.)—The paper summarises the statistics of thunderstorm occurrence in Hungary for the 10 years 1898-1905. The country is divided into 8 districts. The greatest frequency occurs in summer, generally in June. In the eastern highlands the decrease in the frequency on either side of the June maximum is rapid, whereas on the coast it is much more gradual, and winter thunderstorms are not unknown. For the country as a whole, the average number of days on which thunderstorms occur is 25.8 per annum; of these 6.57 occur in June. R. G. K. L.

18. *Luminous Night Clouds and Aurora Spectrum.* C. P. Butler. (Nature, 82. p. 157, Dec. 9, 1909.)—On Dec. 8, a very brilliant display of luminous night clouds was seen by two observers at the Solar Physics Observatory, London. About 10.15 p.m. the sky, previously clear, became suddenly overcast, apparently by formation of haze *in situ*, and not by drifting of clouds. Almost immediately afterwards numerous patches of light cloud appeared, travelling with considerable velocity eastward. The moon was not high enough to account for their brilliancy, and examination with a hand spectroscope confirmed the surmise that they were luminous clouds, the green auroral line being very bright and sharp; on several of the brighter masses other lines were suspected. About 10.45 the clouds became less frequent, and the sky cleared almost as suddenly as it had been overcast. It will be of interest to hear if any magnetic storm has been recorded for this epoch. Numerous spots, rapidly changing, had been in evidence during the week, and one of the largest groups would be passing round the NW. limb. A. E.

19. *Meteorological Evidence for a Change of Position of the Earth's Axis.* F. v. Kerner. (Meteorolog. Zeitschr. 26. pp. 447-454, Oct., 1909.)—A table gives for the whole year, and also for Jan. and July, the difference in mean temperature between successive belts of 10° latitude of the northern hemisphere. For comparison the greatest and least difference occurring between each pair of belts are also given. The variations of the differences actually occurring along a belt are found to be commensurate with the changes which may be assumed to be due to a shift of the pole, and hence we require to be very cautious in drawing conclusions as to the probability of a shift of the pole from meteorological evidence. Thus in Jan. for the belt 60° - 70° , the mean difference of temperature between its northern and southern limits is 9.5° C., but in longitude 145° W. (Alaska) it is as much as 25° . If we suppose a winter flora on the south coast of Alaska (lat. 60°) becomes fossilised, and a shift of the pole through 10° occurs along the 145th meridian, and if, further, the change be accompanied by a change in the configuration of land and sea, such that the Jan. temperature in lat. 70° is unaltered, we might find in lat. 70° a fossil flora which would indicate a Jan. temperature higher by 25° . From the mean distribution of temperature along this belt we might conclude that a shift towards the pole through 27° of latitude had taken place, whereas the actual shift has been assumed to be only 10° . Similar arguments are brought forward for other parts of the world. R. G. K. L.

20. *Azimuth of Earthquake Epicentres.* B. Gallitzin. (Acad. Sci. St. Pétersbourg, Bull. 14. pp. 999-1012, Oct. 15, 1909.)—Two aperiodic and very sensitive horizontal pendulums are employed with galvanometer registering

apparatus. The azimuth of the epicentrum may then be calculated with fair accuracy from the magnitude and direction of the throws of the galvanometers on the arrival of the first preliminary tremor. As the interval between the commencement of the first and second phase vibrations gives the epicentral distance, the observations of a single station are sufficient to locate the seismic origin. The fact that this method of finding the epicentral azimuth is successful in practice shows that the first phase waves are truly longitudinal vibrations. On arrival of the second phase waves, the angle between the plane of vibration of an element of the earth's surface and the plane passing through the epicentrum, the place of observation, and the earth's centre, is in general very small. A. D. R.

21. *Protecting the Silvering of Mirrors.* A. Perot. (Comptes Rendus, 140, p. 725, Nov. 2, 1909.)—The method consists in coating the mirror (which must previously be washed, dried, polished, and freed from dust) with a very thin layer of celluloid. The commercial solution known as Japan varnish, added to an equal quantity of amyl acetate, is used. The mirror, if placed upright to let excess of liquid drain off, will dry in half an hour. Broad, strong, interference bands (8rd order) should then appear, showing that the thickness of the celluloid is uniform and about 0.5μ . The protecting surface, being comparatively soft, must be guarded from scratches, and a feather is recommended for removing dust. The method is said to be very efficacious in preventing tarnishing, while not altering the reflecting qualities of the metallic surface. It has been employed at Meudon Observatory. A. E.

22. *Emission of the Solar Photosphere.* A. Amerio. (Accad. Lincei, Atti, 18, pp. 202-210, Sept. 19, 1909.)—The author points out that on the basis of either of the two hypotheses concerning the nature of the solar photosphere, namely, (1) that it consists of dense, gaseous strata, and (2) that it is derived from the condensation of metallic vapours into drops which remain suspended in the atmosphere, it can be shown, simply and exactly, that the photosphere radiates like a black or almost black body. T. H. P.

23. *Latitude Drift in Sun-spots.* F. J. M. Stratton. (Roy. Astronom. Soc., M.N. 69, No. 9, pp. 659-666, 1909.)—An analysis of Cortie's spot observations in the hope of finding evidence of latitude drift. Of 112 spots identified on return, 87 spots are selected, giving 186 monthly positions to be analysed. The conclusion is that the search for short-period drifts does not encourage one to hope that in them lies the key to the problem presented by the latitude drift of sun-spots. C. P. B.

24. *Photography of Flash Spectrum without an Eclipse.* G. E. Hale and W. S. Adams. (Astraphys. Journ., 80, pp. 222-280, Oct., 1909. Contribution from the Mount Wilson Solar Observatory, No. 41.)—Most of our knowledge of the chromospheric spectrum has hitherto been derived from the observations of Young at a high-altitude station, and from photographs made during total eclipses of the sun. Moreover, as most of the bright lines have their origin in a thin stratum close to the photosphere, they are visible only for a very short interval before and after totality. Recently with the tower telescope at the Solar Observatory, Mt. Wilson, having a 12-in. objective giving a solar image 6.7 in. (140 mm.) diam., and a grating spectrograph

of 80 ft. focal length, it has been found possible to photograph the chromospheric spectrum with great facility. The second-order spectrum gives a scale such that $1 \text{ mm.} = 0.9 \text{ \AA.}$ One of the chief adjustments necessary to the success of the observation is that of keeping the solar image exactly tangential to the slit, as if the photospheric image overlaps the slit the chromospheric spectrum will be overpowered by the bright continuous spectrum. To perform this efficiently a special arrangement of two right-angled prisms was employed near the slit plate, and under direct control of the observer. Lists are given of the lines observed in the region between $\lambda 4491$ and $\lambda 4584$; also between $\lambda 5110$ and $\lambda 5197$. The results of the preliminary measures appear sufficient to indicate that the chromospheric lines are of very nearly the same wave-length as the corresponding Fraunhofer lines, the average residual on 121 lines being only $\pm 0.018 \text{ \AA.}$ This is direct evidence against the idea of Julius that the chromospheric bright lines were due to anomalous dispersion at the sun's limb. If this were so their wave-lengths would be expected to differ appreciably from their normal values. There is thus no reason to suppose that anomalous dispersion has any appreciable effect in connection with these phenomena. C. P. B.

25. *Mass of Moon.* A. R. Hinks. (Roy. Astronom. Soc., M.N. 70. pp. 68-75, Nov., 1909. Solar Parallax Papers, No. 8. Comptes Rendus, 149. pp. 764-766, Nov. 8, 1909.)—This determination has been made from the long series of observations of Eros for the measurement of the solar parallax [Abstract No. 2042 (1909)]. The result gives 81.58 as the relative mass of the earth to that of the moon, assuming a solar parallax of $8.806''$. C. P. B.

26. *Jupiter's South Tropical Dark Area.* S. Bolton. (Nature, 81. p. 487, Oct. 21, 1909.)—During the apparition of 1908-9, 52 transit estimates of the south tropical dark area of Jupiter were observed and have now been reduced to longitude. In Dec., 1908, the area was more than 50° in length at the south equatorial belt; from this date it gradually increased until in June, 1909, it covered more than 90° in longitude. C. P. B.

27. *Oxygen in the Atmosphere of Mars.* J. Very. (Lowell Observatory Bull., No. 41. Nature, 81. p. 529, Oct. 28, 1909, Abstract.)—By employing his spectral band comparator the author finds a decided increase in intensity of the β oxygen-band in passing from the lunar to the Martian spectrum. The increase is given as more than eight times the probable error of the measurements. A. D. R.

28. *Photography of the Planet Mars.* A. de la Baume Pluvinel and F. Baldet. (Comptes Rendus, 149. pp. 888-841, Nov. 15, 1909.)—The photographs were obtained at the observing station on the Pic du Midi with a new double instrument comprising a reflector and a refractor (diam. 0.50 and 0.25 m., focus 6 m.) on a very steady mounting. The focal image of Mars being only 0.9 mm. diam., an enlarging lens was employed, giving discs of 3 to 5 mm. diam. During Sept. and Oct. 80 plates with 1850 images were obtained. At first Lumière violet and Guilleminot lactate of silver plates were used, but soon abandoned, as they rendered the ruddy surface of the planet uniformly grey without any detail. They show the polar caps distinctly, however. The southern cap is much reduced, but very brilliant; at the north pole, on the contrary, a region of the cap is seen which is rather far

from the pole and deficient in brightness. The eastern border of the planet is brighter than the rest of the disc. After the first trials a yellow screen was placed behind the magnifying lens, and plates sensitive only to the rays passing through it were employed, Lumière violet bathed in pinacyanol and others specially prepared. Under these conditions the Martian snows act feebly on the plate; the south cap is still fairly intense, but the north cap, and also the white border on the eastern limb, are invisible. On the other hand, the contrasts between the Martian lands and seas are very apparent, and a considerable amount of detail is shown. The canals of the first order are visible on the photographs, such as Indus, Ganges, Axarxes, &c. No trace appears of the geometric network of fine lines seen by certain observers, the existence of which is disputed. A. E.

29. *Observations of Mars, Visual and Photographic.* Idrac. (Comptes Rendus, 149, pp. 834-835, Nov. 15, 1909.)—The large double telescope of Meudon Observatory was employed. The photographic exposures had to be limited to a fraction of a second, as, owing to the weakness of the mounting, the telescope is in continual vibration. In addition to the south polar cap and other large features, the plates show white patches on the borders of the disc, especially in the region of the equator. These patches, which were also seen visually, appear more intense and extensive on the side of sunrise. On the plates of Sept. 20 the canals Nilosyrtis, Protonilus, and perhaps Nepenthes, are visible. From Sept. 20 the plates also show a broad faint white patch near the north pole (the pole itself is hidden) which was not seen visually. On Sept. 25 this patch extends as far as lat. 55° . Attempts were made to take photographs with the visual telescope of the doublet, by using orthochromatic plates and a yellow screen. These, however, were unsuccessful, serving only to confirm Lowell's observation that the contrasts between the "seas" and "continents" are more marked with the red and yellow rays than with the violet. A. E.

30. *Observations of Mars made at Meudon.* E. M. Antoniadi. (Comptes Rendus, 149, pp. 886-888, Nov. 15, 1909.)—The planet was studied with the 0.88 m. telescope, with magnifications 820, 470, and 800 diams., on thirteen nights from Sept. 20 to Nov. 9. The results are combined in a chart attached to the paper, which shows much detail and many canals. Among the most remarkable changes noticed since the opposition of 1907 were, the return of Syrtis Major to its form of 1864 and 1877, the reappearance of Lac Moeris, and the formation of a multiple "island" in the eastern region of the Mare Cimmerium. At the same time the planet was partly veiled by mists or light cirrus, which lightened the indigo-grey tone of the "seas" and gave a yellowish hue to the "continents." The tint of these mists or cirrus varied, according to their intensity, from golden-yellow to dull white. Their effect sometimes in almost obliterating spots which had appeared black a few days earlier was very remarkable. Some 50 "canals" were observed. The author, adopting Schiaparelli's definition of a canal, as a greyish band or line in the regions called "continental," assuming all kinds of forms, and longer than the more or less elliptic spots called "lakes," proceeds to divide the canals into eight classes. The list does not include the fugitive straight lines, often also called canals, which are only visible a fraction of a second, and may be illusory. The observations here dealt with do not confirm the existence of a geometric network of straight lines crossing in all directions. Indeed, sometimes with very steady images, glimpses, not fugitive, but lasting

several seconds, were obtained of a structure of an entirely different character in the continental regions. These regions appeared covered with a great number of greyish marblings, irregular and complex, which no artist could reproduce.

A. E.

31. *Studies of the Planet Mars.* R. Jonckheere. (Comptes Rendus, 149. pp. 969-971, Nov. 29, 1909.)—The observations were made at the observatory of Hem with a refractor of 0.85 m. aperture, and 6.5 m. focus. A list is given of measures of the south polar cap from July 16 to Nov. 18. The greatest value is $4.38''$ or 82° (aerocentric arc) on July 16, and the least $1.28''$ or 9.5° on Nov. 14. The widths are influenced by the longitude, and by the presence of lands covered with snow in the vicinity. An island, identified as Novissima Thyle, emerged from the polar snows on Aug. 11, Argyre II. was seen on Sept. 2, and the same night a new land (120° , -84°) was discovered in the polar snows, and named Stella from its brightness. All these were measured for position. The canals began to appear Sept. 1, and 28 new ones were observed. Another new land (100° , -48°) was found Oct. 5, and named Thaumias. From measures of the diam. of Mars on Sept. 21, 23, 24, 27, the value $24.825''$ was deduced for the mean diam. This gives for unit distance the value $9.588''$, corresponding to a radius 3444 km. The polar flattening was measured as 1:2708.

A. E.

32. *Duration of Rotation of Mercury.* R. Jarry-Desloges. (Comptes Rendus, 149. pp. 966-969, Nov. 29, 1909.)—The paper contains reproductions of 16 drawings of Mercury, viz., 8 by G. Fournier, and 8 by V. Fournier, from which the author infers that the rotation-period is long, probably equal to the planet's time of revolution. The drawings were made on the Masegros (altitude 900 m.) with a refractor 0.29 m. aperture, on evenings Sept. 15-20, 1909, about half the planet's disc being illuminated. They show a very few dark shaded streaks, two or three branching from the central region, one parallel to the south-west limb, and one cutting across the north cusp. A dark dot is shown on some of the drawings in the south-east, one observer placing it at the intersection of two streaks. A dark region is indicated near the equator. The south horn is sometimes shown rounded or shaded. There is fair approach to agreement between the drawings of the two observers, considering that the objects delineated are at the limits of visibility. The author remarks that in the short moments when the images were less unsteady than usual, the dark regions on Mercury appeared as dark as the average tint of those on Mars; and that the difficulty in rendering details is mainly due to the bad quality of image peculiar to this class of study.

A. E.

33. *Size of Meteors.* C. Fabry. (Astrophys. Journ. 80. pp. 818-820, Nov., 1909.)—In criticism of the estimates of W. H. Pickering that a meteor of the third magnitude must be from 6 or 7 in. in diameter to a mere grain according as its brilliancy was similar to that of the electric arc or immeasurably greater, the author thinks them contrary to well-known photometric results. From actual measurements it has been found that a star of zero magnitude gives an illumination of about 2.1×10^{-4} candle-metres, when the star is at the zenith and the observer at sea-level, under good atmospheric conditions. This would mean that a meteor of third magnitude, 150 km. from the observer, should have a luminous intensity of 8000 candles, or, allowing for atmo-

spheric absorption, say 4500 candles. The crater of an electric arc gives about 200 candles per mm.². Such a meteor would have a diam. of about 25 mm., and if of density 4, would weigh about $\frac{1}{4}$ gm. or 4.5 grains. C. P. B.

34. *Measurement of Stellar Temperatures*. C. Nordmann. (Comptes Rendus, 149, pp. 557-560, Oct. 4, 1909.)—The application of his stellar photometer to the measurement of several standard sources led the author to attempt the problem of assigning relative temperatures to the various groups of stars as differentiated by their spectral constitution. The series of temperatures found range from 2,980° abs. (ρ Persei) to 80,000° abs. (λ Tauri). The scale is compared with the Kensington temperature classification, which is based on the variation of the enhanced lines of the constituent elements, and a general similarity recognised. [See Abstract No. 2020 (1909).] C. P. B.

35. *Electrical Measurement of Starlight*. J. Stebbins. (Science, 30, p. 726, Nov. 19, 1909. Paper read before the Astronom. and Astrophys. Soc. of America.)—Further experience with the selenium photometer for the measurement of starlight has indicated the advisability of refrigeration for keeping the selenium cell at a constant low temperature. During the past summer the accuracy of the method has been so increased that it is now possible to measure first magnitude stars with a probable error of less than 0.01 magnitude. C. P. B.

REFERENCES.

36. *Observations on Indicators*. A. N. Krylov. (Acad. Sci. St. Pétersbourg, Bull. 9, pp. 628-654, May 15, 1909.)—A mathematical paper, dealing with the actions of (1) indicators, in which the mass of the spring is quite small compared with that of the piston, while the spring is perfectly elastic, so that the piston returns to its original position on discontinuance of the pressure; (2) apparatus for registering the max. pressure; in these the piston acts on a column of negligible mass which retains its greatest compression on removal of the pressure. T. H. P.

37. *A Gyrodynamical Amagnetic Mariner's Compass*. J. J. Taudin Chabot. (Phil. Mag. 18, pp. 729-739, Nov., 1909.)—Description of instrument with discussion of the theory involved.

38. *Mechanical Integrator*. E. Pascal. (Accad. Lincei, Atti, 18, pp. 304-312, Nov. 7, 1909.)—An integrator is described and illustrated which, while claimed to be more simple in construction than that of Abakanowicz [Abstract No. 2478 (1904)], may be used not only for quadrature, but also for tracing a logarithmic curve or catenary, or for the resolution of algebraic equations. W. H. St.

39. *Two Mercury Manometers for Low Pressures*. K. Scheel and W. Heuse. (Zeitschr. Instrumentenk. 29, pp. 344-349, Nov., 1909. Communication from the Physikal.-Techn. Reichsanstalt.)—The first of these manometers is made after the Rayleigh model [see Abstract No. 1652 (1901)], the instrument being modified to raise its upper limit of measurement from 1.5 mm. to 5.0 mm. with the same accuracy, viz., to 1/2000 mm. The second manometer is constructed to measure pressures up to 80 mm. [See also Abstracts Nos. 268, 1715 (1909).] G. E. A.

40. *Method of determining Sensibility of a Balance.* J. H. Poynting and G. W. Todd. (Phil. Mag. 18. pp. 132-135, July, 1909.)—Description of a micrometer screw arrangement for shifting a "rider" a definite distance along the balance-arm.

41. *Steady Flow of Incompressible Viscous Fluid through Circular Tube.* A. H. Gibson. (Phil. Mag. 18. pp. 35-38, July, 1909.)—Mathematical.

42. *Propagation of Disturbance in a Dispersive Medium: Waves on Water.* Rayleigh. (Phil. Mag. 18. pp. 1-6, July, 1909.)—Mathematical.

43. *Flight of a Rifled Projectile in Air.* J. B. Henderson. (Roy. Soc., Proc. Ser. A. 89. pp. 314-331, June, 1909.)—A mathematical and graphical discussion dealing with the influence of gravity on the trajectory, and the vertical drift.

44. *Position Determination from Balloons.* C. Runge. (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 3. pp. 289-307, 1909.)—A very full discussion which, owing to its mathematical nature, is unsuitable for abstracting. L. H. W.

45. *Hydroplanes or Skimmers.* J. Thornycroft. (Engineering, 88. pp. 813-815, Sept. 3, 1909. Paper read before the British Assoc. at Winnipeg.)

46. *Relations in Capillarity.* R. D. Kleeman. (Phil. Mag. 18. pp. 491-510, Oct., and pp. 901-908, Dec. 1909.)—The author has derived mathematically a number of relations between the potential energy of the surface of a liquid and various other physical constants, the expressions obtained being confirmed for a large number of organic compounds. T. H. P.

47. *Light Nights during the Summer of 1908.* A. Stentzel. (Meteorolog. Zeitschr. 26. pp. 437-446, Oct., 1909.)—Daily observations of the optical phenomena noted at sunset or sunrise are given for the period June 1 to July 31, 1908. Observations were made partly in Hamburg and partly in the Giant Mountains. Special attention was devoted to colour effects. The gradual growth and decline of the phenomenon is traced. No discussion of the results from the point of view of theory is attempted. R. G. K. L.

48. *The Upper Air.* (Nature, 82. pp. 47-49, Nov. 11, 1909. Report of Committee to the British Assoc. at Winnipeg, 1909.)—The report summarises the present state of our knowledge of the upper air. It is divided into three sections. (1) Historical. (2) Instruments and apparatus. (3) Temperature results: (a) Mean gradients. (b) Temperatures under cyclonic and anticyclonic conditions. (c) The advective and convective regions. (d) Annual variation. (e) Diurnal variation. (f) Wind results. R. G. K. L.

49. *Earthquake of October 20-21, 1909.* B. Galitzin. (Acad. Sci. St. Petersburg, Bull. 16. pp. 1107-1112, Nov. 15, 1909.)—The position of the epicentrum was calculated from the Pulkowa seismograms alone by the author's method [see Abstract No. 20 (1910)], and the results were found to agree closely with the subsequently published reports. The calculations are given in the paper. A. D. R.

THE AUTHOR SUGGESTS TWO SCREENS OF THIN CELLULOID DYED, ONE WITH METHYL-VIOLET AND THE OTHER WITH ANILINE BLUE, WHICH MAY BE USED SINGLY OR TOGETHER FOR THE DETECTION OF VARIOUS SUBSTANCES BY THEIR FLAME REACTIONS. FOR EXAMPLE, PHOSPHORIC ACID MAY BE DETECTED IN THE PRESENCE OF Na, AND Ca IN THE PRESENCE OF Sr. A. M. E. C. C. B.

LIGHT: 50. *New Light-filter for use in examining Flame Colourations.* H. E. Merwin. (Science, 30, pp. 571-572, Oct. 22, 1909.)—The author suggests two screens of thin celluloid dyed, one with methyl-violet and the other with aniline blue, which may be used singly or together for the detection of various substances by their flame reactions. For example, phosphoric acid may be detected in the presence of Na, and Ca in the presence of Sr. A. M. E. C. C. B.

50. *New Light-filter for use in examining Flame Colourations.* H. E. Merwin. (Science, 30, pp. 571-572, Oct. 22, 1909.)—The author suggests two screens of thin celluloid dyed, one with methyl-violet and the other with aniline blue, which may be used singly or together for the detection of various substances by their flame reactions. For example, phosphoric acid may be detected in the presence of Na, and Ca in the presence of Sr. A. M. E. C. C. B.

51. *A Wave-length Comparator for Standards of Length: Instrument for Fine Measurements in Wave-lengths.* A. E. H. Tutton. (Roy. Soc., Phil. Trans. Ser. A. 210, pp. 1-34, Oct. 28, 1909. Proc., Ser. A. 88, pp. 79-81, Nov. 8, 1909. Abstract.)—A full description of a comparator recently designed for, and set up by the Board of Trade for measurement of standards of length. The essence of the instrument is that homogeneous light of a definite wave-length is directed normally upon two plane surfaces arranged close together, and nearly, but not absolutely, parallel. The two reflected rays give rise to interference bands. The method of comparison of two standards of length is as follows: One standard is mounted in the instrument, and one of its defining marks adjusted under the spider line of a fixed microscope. A second microscope carrying one of the plane glass surfaces is brought into position so that its spider line is absolutely fixed on the second defining mark of the standard. The second plane glass surface is rigidly fixed, and the interference bands are examined in a properly constructed telescope. The first standard is now replaced by the standard to be compared and carefully adjusted so that its first defining mark is exactly under the spider line of the first microscope. If the second defining line is exactly under the spider line of the second microscope, then of course the two standards are exactly equal in length. If, however, the second defining line is not exactly under the spider line of the second microscope, this microscope is moved by a very accurate screw until the spider line and defining mark coincide. The distance travelled by the microscope is measured by counting the number of interference bands and fractions of a band which pass the reference spot in the telescope, and multiplying that number by half the wave-length of the light employed. For the full details of the instrument the original must be consulted. E. C. C. B.

52. *Refractivity of Radium Emanation.* A. W. Porter and C. Cuthbertson. (Nature, 82, pp. 7-8, Nov. 4, 1909.)—The quantity of emanation available was only about $\frac{1}{10}$ mm.³, and the form of refractometer employed was on the principle of the Fabry and Perot *etalon* which utilises the gas layer twice. The containing vessel was about 2.8 mm. long and 0.71 mm. in diam., and the emanation could be compressed within it by means of a column of mercury. The green beam from a Bastian mercury lamp was used, and the apparatus had an optical efficiency of about 2 per cent. Many difficulties were encountered, chiefly through the rapid generation of impurities originating in the action of the emanation on the resinous cement employed, which made it impossible to calculate the true index of the

emanation. The direction in which the refractivity lies, however, is indicated by the highest values found, viz., 0.000840 for 0.206 mm.¹ and 0.000916 for 0.128 mm.² measured at atmospheric pressure. The quantity of emanation was approximately the same for both measurements, and equalled the quantity in equilibrium with 0.178 gm. of radium. The higher of the above values is about 26 times the value for helium. G. E. A.

53. *Apparent Dispersion of Light in Space.* C. V. Burton. (Phil. Mag. 18. pp. 872-877, Dec., 1909.)—A theoretical note on a point raised by the work of Nordmann and Tikhoff. [See Abstracts Nos. 590, 591, 1892 (1908), 1018 (1909)]. From a consideration of the known absorption caused by matter it would seem that any definitely proved dispersion of light in interstellar space would have to be attributed to properties of the ether itself. Using the mechanical analogy of the loaded string, the group velocity for disturbances of given wave-length is deduced from first principles in terms of λ and of b , the common distance between two particles on the string. Using astronomical data, the values of b found are 1.7×10^{-9} cm. and 8.1×10^{-9} cm. Taking the Thomson value 10^{-13} cm. for the radius of a corpuscle along with other considerations, it appears that the dispersion announced by Tikhoff and Nordmann is of an altogether greater order of magnitude than could be accounted for by coarseness of structure of the ether. G. E. A.

54. *Dispersion of Electric Double Refraction.* H. E. McComb. (Phys. Rev. 29. pp. 525-540, Dec., 1909.)—A determination of the double refraction constant for twelve liquids for various colours of the spectrum, and a comparison of these constants with the refractive index by means of Havelock's formula [see Abstract No. 653 (1909)], $B\lambda n_0(n_0^2 - 1) = C$, where B is the double refraction constant, λ the wave-length, n_0 the refractive index, and C a constant for the substance. For waves from 440 to 660 $\mu\mu$, Havelock's equation is in agreement with the results obtained for the twelve liquids. [See also Abstracts Nos. 529 (1905), 1872 (1906), and 1780 (1908)]. C. A. Skinner. (Ibid. pp. 541-552, Dec., 1909.)—Skinner gives the results of an investigation of the magnetic double refraction of the liquids examined by McComb. They corroborate in general the conclusions of Cotton and Mouton [see Abstract No. 1508 (1907)], and the form of the dispersion curve fits, in most cases, the theory of Havelock. The apparatus was about the same as that used recently [see Abstracts Nos. 283, 285, 1606 (1908), also No. 448 (1909)]. G. E. A.

55. *Resolving Power of Photographic Plates.* C. E. K. Mees. (Roy. Soc., Proc. Ser. A. 88. pp. 10-18, Nov. 8, 1909.)—The resolving power of plates as measured by the irradiation displayed is investigated for plates with grains from 0.004 to 0.0004 mm. Plates with a medium grain gave the best results. The irradiation was therefore attributed to two causes, viz., reflection with coarse grains, and diffraction with fine grains. This hypothesis gains support from the fact that with fine grains the irradiation was dependent on the wave-length of the incident light and the thickness of the film, while with coarse-grained plates there was little or no change. For resolution it is shown that lines must be separated by about 0.08 mm. for coarse, and 0.018 mm. for fine-grained plates. The former corresponds to about 0.1 Å.U. in 6.5-m. focus grating-spectroscopes with 14,488 lines to the inch. A. D. R.

56. Herschel Effect. K. Schaum. (Zeitschr. wiss. Phot. 7, pp. 399-401, Oct., 1909.)—The reversing action of long waves, particularly in the infra-red, has been recently denied in relation to gelatine plates; but it exists; it has been utilised by Millochau in investigating the infra-red spectrum [Abstract Nos. 1376, 1555 (1906)]. The action of ordinary light seems to be to produce first a developable subhaloid α and then a non-developable subhaloid β ; β is reconverted into α , and α into normal haloid by the action of long waves. The transformation of normal haloid into a subhaloid is effected by shearing, by Röntgen rays, by spark light, and by ordinary light, in that order of effect produced; the transformation of α into β by the same in the reverse order of effect. A. D.

57. Solarisation. G. A. Perley. (Journ. Phys. Chem. 13, pp. 680-688, Nov., 1909.)—Oxidising agents (hypobromous acid, permanganate solutions) do not facilitate reversals, but produce clearness of the positive produced by exposures beyond the first maximum; while in the absence of oxidising agents long exposures produce both an intense reversed image and a feeble normal image. The conclusion is that the oxybromide theory of the latent image is of no avail, and that the latent normal image consists, at least in the beginning, of silver and bromine only. The reversal of an image is checked by the use of a weak or restrained developer. Nitrites or hydroquinone developer present in the film during exposure do not prevent reversal, but may mask it by making the normal image dense or by causing the effect of light to go on to the production of a print-out negative image; but by adjusting the degree of concentration and the amount of exposure, positives may be formed even with rapid exposures, as also by developing under coloured light after exposure, or by treating the plate first for a long time (say 30 min.) with a weak developer, then for a shorter time (say 10 min.) with normal developer. The action of hypophosphites, said to be analogous to that of light, is traced to a reducing or a solvent action according to time and concentration, apparent reversals being really due to the solvent action. Thiocarbamide solution gives the ordinary development of the shortest exposures as negatives, but the negative is always followed by a positive; the negative on the surface, the positive on the glass side of the film. The negative image may be developed with a weak developer and dissolved out, and the positive then developed with thiocarbamide solution. Thiocarbamide seems to develop the undecomposed AgBr more rapidly than the exposed; and it seems to cause an increase in the sensitiveness of the undecomposed AgBr and also to exercise a solvent action upon it. Negatives are produced under special conditions, but are followed by positives if the development be continued. A. D.

58. Latent Images. H. J. Channon. (Photographic Journ. 49, pp. 875-877, Nov., 1909.)—Villard found (1899) that white light undoes the effect of Röntgen rays as regards (1) the fatigue induced by the latter in a platinum-cyanide screen and (2) the developability induced in a gelatino-bromide plate by exposure to the latter. Longer action of white light, in the latter case, causes a positive radiograph on development; or a plate wholly Röntgenised and then exposed in the camera will give a positive direct on ordinary development. These phenomena are not explicable on the old sub-bromide hypothesis of the latent image. There appear to be different varieties of latent image, all developable but otherwise not the same; the Röntgen-ray

latent image is one; Waterhouse's on pure silver plates, another; the latent image produced by red or yellow light, or by the action of red or yellow light on films previously exposed to white light again differ in their experimental behaviour.

59. Sensitising of Photographic Plates to the Red and Infra-red. G. de Monceiz. (Comptes Rendus, 149, pp. 851-852, Nov. 15, 1909.)—The following formula has been used with great success: Water, 55 c.c.m.; alizarin blue bisulphite solution (0.2 per cent.), 8 c.c.m.; ammonia (concentrated), 1 c.c.m.; alcohol, 42 c.c.m.; nigrosine B (0.2 per cent.), 2 c.c.m.; pinacyanol (0.1 per cent.), 80 drops. Plates bathed in this solution are sensitive to a longer wave-length than $\lambda = 8600$. All plates do not give equally good results, but the best are the bromo-iodide plates made by Jougla. The alizarin blue bisulphite solution must be quite fresh.

60. Light of the Firefly. W. W. Coblentz. (Electrical World, 54, pp. 1184-1185, Nov. 11, 1909. Phys. Zeitschr. 10, pp. 955-956, Dec. 1, 1909.)—The author has had considerable experience in measuring radiometrically the light emitted by fireflies. Exceedingly sensitive radiometers must be used. The sensitiveness of the radiometer used in measuring the heat from stars is about one-fourth of that used in measuring the spectral distribution of energy from gases in vacuum tubes. For the latter measurements, 1 mm. deflection on the scale represents a rise in temperature of only $\frac{1}{10000}$ of a degree Cent. On several calm, cloudy days, with window-blinds closed, the author found it possible to work with a sensitiveness of 1 mm. deflection, equivalent to seven-tenmillionths of a degree; the time required to obtain an observation being about 1 min. It is evident, therefore, that only an insect emitting a continuous glow can be investigated radiometrically. The photographic method is preferable, but it cannot tell whether there is infra-red radiation. The colour of the emitted light varies from green to yellow and red. The latter colour is rare, and it has been stated that it is probably due to absorption in passing through the chitinous layer. An examination of several different species showed that in all cases the outer integument covering the insect, i.e., the chitinous layer, was found to be perfectly transparent in the regions covering the luminous organs. This shows that the colour of the transmitted light is not due to absorption. The author shows that even if heat waves of lengths greater than 2μ were produced in the photogenic cells it is quite certain that they could not pass through the chitinous layer. Instead of attempting to confirm Langley's observations on the infra-red radiations due to the natural body temperature, it is better to find the radiation from a firefly using a piece of clear glass to absorb the radiation beyond 8μ , that is the "animal heat," and then absorb the visible radiation by means of Schott's red glass, which is unusually transparent between 1μ and 2μ . The firefly's light stops abruptly in the red, and its spectral energy distribution is similar to that of fluorescent light, which is generally a transformation downward from an excitation of shorter wave-length. Why not credit the firefly with a step-down process of excitation, the resultant emitted waves being similar to the ordinary fluorescence spectra? The author concludes with a reference to papers by Watafe (Biological Lectures, 1895, Marine Biol. Lab., Woods Holl).

61. Electrical Character of the Source of Light Radiation. T. P. Irving. (Phys. Rev. 29, pp. 248-257, Sept., 1909.)—An investigation into the electrical

character of the Bunsen flame in the absence and presence of volatile metallic salts. A divided Bunsen flame was used as employed by Fredenhagen, so that the inner and outer cones could be examined separately. The electrical character of the flame itself, and the charge upon the metallic particles were observed by the use of exploring electrodes or plates which could be charged to a high potential by a friction electrical machine. The metallic vapours were introduced by Beckmann's method. The results obtained show that the metal vapours are electropositive in the inner cone, and that they tend to become partly or entirely neutralised in the outer cone. Li becomes neutral, Na, K, and Rb become less strongly positive, while Cs remains apparently as strongly positive as in the inner cone. This may either be due to oxidation processes (Fredenhagen) or to a combination with free negative electrons. Further, it was noticed that the electrical wandering of the metallic particles in the inner cone for the first Mendeléeff group, increases with atomic weight. If the second explanation above be adopted, it would seem that more free negative electrons are required to neutralise the ions or atoms of higher atomic weight. An important result was also obtained in that the principal series lines appeared in the spectrum of sources showing qualitative differences, and therefore the principal series arise from a positive or neutral source. [See Abstracts Nos. 650 (1906), 1785 (1906), 1281, and 1878 (1906)].

62. *New Method of Measuring Light Efficiency.* C. C. Hutchins. (Amer. Journ. Sci. 28, pp. 529-582, Dec. 1909. Abstracts in Elect. Rev. and West. Electr. 55, pp. 1194-1195, Dec. 18, 1909. Electrician, 64, p. 660, Jan. 28, 1910).—Measurements of light efficiency are attended by unusual difficulties. For example, to compare the integral visible energy, expressed in a radiation curve, with the total energy is both a tedious and an uncertain process. The author therefore suggests a method based on the following theoretical principles: If a denote the visible and b the infra-red energy $a/(a+b)$ represents the efficiency. Now, assume that a water cell, which is perfectly transparent to light and imperfectly transparent to energy in general, is introduced in the path of the light examined; as a result some infra-red energy passes (the curve reaching the abscissa about 1.8μ), and an amount of energy, say $a+c$, is transmitted. Next imagine that a cell transmitting rather more or less infra-red energy but otherwise identical is introduced, and that it transmits an amount of energy d . Then from a knowledge of $a+b$, $a+c$, and d , and the ratio of c to d , which can be easily and accurately obtained from the transmitted curves of energy-radiation, we can calculate $a/(a+b)$. The author then proceeds to describe some experiments to verify this process, the radiant energy being measured with a bolometer. Details of the exact nature of the apparatus and various precautions are given. The author also remarks that 0.76μ has been commonly assumed as the termination of the visible red in the spectrum, and he follows the usual system in order to render his results comparable with those of other observers. He has found, however, that this limit only exactly corresponds with fact in the case of sunlight. As an example of the method the author gives the result of an experiment on the acetylene flame. After correction for the absorption of the water-cell the efficiency works out at 0.0809, and this is stated to agree well with the figure of Nichols and Coblenz, who found 0.088 by the integration method and 0.080 by a method based on a comparison of the transmission curves through water and a solution of iodine in carbon bisulphide.

63. *Constitution of White Light.* A. Eagle. (Phil. Mag. 18, pp. 787-798, Nov., 1909.) Paper read before the Physical Soc., June 11, 1909.—According to the modern theory of white light founded by Gouy and developed by Rayleigh, Schuster, and others, white light does not consist of periodic wave-trains of all wave-lengths, which are simply separated or "dispersed" when it is drawn out into its spectrum, but consists essentially of a succession of non-periodic pulses emitted independently of one another. It is out of such pulses that the spectroscopist builds up the periodic wave-trains we observe in the spectrum. If these pulses are all similar and follow one another quite at random, it follows that the distribution of energy in each pulse must be the same as the distribution of energy in the total succession of pulses. The distribution of energy in the spectrum obviously depends on the shape or form of the pulses making it. Rayleigh has shown how the distribution of energy in a pulse of any given form could be calculated, and calculates the distribution of energy for a pulse of the form $f(t) = e^{-t^2}$. Other suggestions as to the form of the pulse have been made by others, and the corresponding distribution of energy calculated. In no case, however, has a form been hit upon which gave a distribution in accordance with fact. The inverse problem, viz., from the distribution of energy to find the form of pulse which would give rise to it, seems not previously to have been published, and its solution is the object of the present paper. The problem, however, is stated to be one which does not admit of a definite solution, as the distribution of energy in the spectrum is independent of the relative phases of the infinitesimal harmonic components out of which the pulse may be considered to be built up; whereas its form must obviously depend as much on the relative phases of the components as upon their relative amplitudes. The subject is then mathematically discussed, Rayleigh's, Planck's, and Wein's formulæ for full radiation being used. Since the pulses correspond to the *accelerations* of electrons, two integrations yield the *displacements* of the electrons which, for Rayleigh's formula, came out $y = A \log(a^2 + t^2)$ and $y = B \tan^{-1} t/a$, where $a = b/V$. E. H. B.

64. *Talbot's Fringes and the Echelon Grating.* R. W. Wood. (Phil. Mag. 18, pp. 758-767, Nov., 1909.)—The author explains the formation of Talbot's fringes when the retarding plate is introduced from one side and not from the other without the elaborate mathematical treatment given by Airy and Stokes, and extends the explanation to the echelon grating. He maintains that Schuster's explanation of the failure of the bands to appear when the plate is introduced from the wrong side is not perfectly satisfactory. Assume plane waves of monochromatic light incident upon a rectangular aperture brought to a focus by a lens. The first diffraction minima to the right and left of the central maximum will lie in directions such that the path-difference between the disturbances coming from the edges of the aperture is a whole wave-length. If the right-hand half of the aperture is covered with a transparent plate which retards the wave-train by $\lambda/2$, then the illumination at the centre will be zero, and two bright maxima will occupy the position of the first minima. If the change from the first to the second condition be considered as gradual, that is to say, if a plate of infinite thinness be introduced and slowly increased in thickness, then clearly the central maximum will move to the right with a decrease in intensity, while the neighbouring maximum to the left increases in brightness, moving in the same direction. An increase in the thickness of the retarding plate causes

therefore a steady march of the fringes to the right. If the thickness of the plate be constant and the wave-length of the light be steadily decreased the same march of the fringes will occur. If two wave-trains are present in the incident light and the retardation for these is respectively an odd and even number of half wave-lengths, the single and double maxima will exist simultaneously, or in other words, the lines are not resolved. An increase in the number and thickness of the retarding plates will, of course, give resolution with smaller difference in wave-length between the two trains. The high resolving power of the echelon grating is therefore at once arrived at. Considering now the Talbot fringes, if the slit of a spectrometer be illuminated with monochromatic light, and the plate introduced into the beam behind the prism and the plate cause a retardation of an even number of half wave-lengths, a single bright line will be seen with accompanying maxima and minima. A slight decrease of wave-length will cause a slight movement of the line to the right if the action of the prism be disregarded. The action of the prism will, however, cause a slight shift to the left. If these two shifts be equal in amounts and the slit be illuminated simultaneously with all the wave-lengths in a range, say, of 100 Å.U., a series of bright lines will be seen to the intensity of which all the waves will contribute. Consider a large number of equidistant monochromatic constituents of the spectrum A, and another set B, midway between them. The distance between a line A and a line B is such that the difference in retardation is $\lambda/2$. If the retardation for the A lines is an even number of $\lambda/2$ they will remain fixed in position and single. The lines B will double, and fall upon the lines A, thus causing the Talbot fringes. As far as the lines A and B are concerned it will be immaterial from which side the retarding plate is introduced, but if the elements between the A and B lines are considered, in one case they are shifted so as to fall on the lines A, while in the other they are shifted so as to fall in between. In the latter case a continuous spectrum is formed if the regions A and B are infinitely narrow. The Talbot bands can thus be accounted for without utilising Schuster's idea that a stream of waves that is already behind another cannot interfere with the latter by further retardation. Talbot's fringes would be formed even if the two streams could interfere regardless of which one was retarded. This explanation thus assumes interference as still taking place, even though the Talbot fringes are absent when the plate is put in from the wrong side. On a supplemental note the author claims to have shown by the use of a second spectroscope that interference does actually occur in the absence of the fringes. [See next Abstract.]

65. What is Interference? A Rejoinder to R. W. Wood. A. Schuster. (Phil. Mag. 18, pp. 767-770, Nov., 1909.)—A criticism of Wood's use of the word "interference," which the author maintains is wrongly interpreted. The real meaning is that, if the observed illumination of a surface by two or more pencils of light is not equal to the sum of illuminations by the separate pencils, then interference is taking place. There is no indication in Wood's paper that interference is taking place when the bands are not visible. The use of the second spectroscope by Wood complicates the phenomenon by introducing the conditions necessary for interference, and the observations made with it have no bearing on the question whether there was interference in the original spectrum or not. [See preceding Abstract.]

E. C. C. B.

86. *Spectrographic Analysis of some Blendes.* G. Urbain. (Comptes Rendus, 140. pp. 602-608, Oct. 11, 1909.)—A spectrographic analysis of 64 different samples of blende, the arc spectrum in each case being photographed. In 88 of these the presence of Ge was proved, 5 containing sufficient of this element for all of its lines to be recognised. The distribution of Ge is of the same order as that of In. The blendes rich in Ge, however, were rich in Ga but poor in In. Full details will be published elsewhere. E. C. C. B.

87. *Infra-red Spectrum of Ice.* G. Bode. (Ann. d. Physik, 30. 2 pp. 826-886, Oct. 14, 1909. Physikal. Inst. d. Univ., Berlin, June, 1909.)—Small plates of ice are formed in suitable carriers and placed in an apparatus kept at a low temperature. The rays from a Nernst lamp after passage through a reflection spectrometer provided with a fluor spar prism are passed through the apparatus holding the plate of ice, after which they are reflected on to a Boys' radiomicrometer. There are distinct maxima of absorption at 1.5 , 1.95 , and 3μ , which are also present in the absorption curve for water. The reflecting power of ice is also measured by the method employed by Rubens and Ladenburg for water, and the reflecting power—wave-length curve shows a maximum at 8.2μ . But using frozen soap solution, a distinct absorption maximum was found at 4.5μ , and it is concluded that ice is exactly analogous to water in its behaviour in the infra-red spectrum as far as 6μ . G. E. A.

88. *Band Spectra of Barium and Aluminium.* L. de Boisbaudran. (Comptes Rendus, 140. pp. 899-908, Nov. 22, 1909.)—In the author's opinion the band spectra of metals are due to the perturbations of the more simple vibrations which obtain at high temperatures, and in the present paper he puts forward certain calculations in support of this. The measurements are taken of the extreme edges of the heads of the bands, and in the case of Ba the mean of the frequencies of the 18 heads is 1806.91. The band with a frequency of 1820.98 is the central band on which falls the high-temperature line with a frequency of 1806.92. The difference between the frequencies of the mean of the 18 bands and the high-temperature line is 1.01, or in wave-lengths $8.1 \text{ \AA.U.}$ The twelfth root of the product of the frequencies of the 19 bands (omitting the central one) is 1799.08, and the square root of the product of this and the frequency of the central band is 1806.98, which is almost exactly equal to the frequency of the high-temperature line 1806.92. Similar relations hold with the bands of Al. E. C. C. B.

89. *Spectrum of Magnesium Hydride.* A. Fowler. (Roy. Soc., Phil. Trans. Ser. A. 209. pp. 447-478, Oct. 22, 1909.)—A complete measurement of the lines of the so-called magnesium hydride spectrum between the limits $\lambda = 5621$ and $\lambda = 4871$. The spectrum is obtained when the arc is formed between Mg poles in an atmosphere of hydrogen, preferably under reduced pressure. From experiments made, the author concurs with Living and Dewar in their opinion that the flutings in question are due to Mg associated in some way with hydrogen. The spectrum is very complex and contains numerous lines which extend from the red to the extreme ultra-violet. There are five flutings with their heads at 5621.57, 5211.11, 4944.92, 4871.8, and about 2480. The first three flutings only were accurately measured, and the wave-lengths of the lines were derived from the Fabry and Buisson standards, but were afterwards converted to Rowland's scale for comparison with sun-spot spectra. Twelve of the series of lines which compose the green fluting

have been traced. None of the present formulæ express all these series within the limits of experimental error. For the longest series Halm's equation gives the closest approximation. The identification of magnesium hydride in the sun-spot spectrum has been fully confirmed. The presence of these flutings and of those of titanium oxide and calcium hydride accords with the view that spots are regions of reduced temperature. E. C. C. B.

70. *Spectra of Compounds of Alkaline Earths.* A. Eagle. (Astrophys. Journ. 80. pp. 281-286, Oct., 1909.)—This research was suggested by the discovery of the lines of various alkaline earth compounds in the spectra of sun-spots; of magnesium hydride by Fowler [Abstract No. 208 (1908)]; of calcium hydride by Olmstead [Abstract No. 569 (1908)]. Arcs of the chlorides of Ba and Sr on carbon piles were run in a rarefied hydrogen atmosphere. To differentiate between the spectra of various compounds of an element, comparisons were made of the oxides and chlorides in air. Two plates are given showing the spectra obtained under various conditions. It is concluded that there is no evidence of the existence of either barium or strontium hydride lines in the sun-spot spectrum. C. P. B.

71. *Influence of the Medium upon the Lines of Spark Spectra.* H. Finger. (Deutsch. Phys. Gesell., Verh. 11. 17. pp. 869-876, Sept. 15, 1909. Zeitschr. wiss. Phot. 7. pp. 829-856, Sept., and pp. 869-891, Oct., 1909.)—A detailed examination of the spark spectra of 17 metals under water. The results obtained by a comparison of these with the same in air are very complex, and suggest that a complete investigation with great dispersion and accurately controllable electrical conditions is necessary for their explanation. Certain points are noteworthy, however, amongst which may be mentioned the fact that the series lines within one family behave in the same way, as also do the enhanced lines. Also the change from air to water as the medium causes the spectra to vary in a different way from that observed on merely increasing the pressure of the air. E. C. C. B.

72. *Arc and Spark Spectra of Titanium, Manganese, and Vanadium.* C. M. Kilby. (Astrophys. Journ. 80. pp. 248-266, Nov., 1909.)—Tables of the lines of the arc spectra reduced from photographs obtained with a concave Rowland grating of 21.5 ft. radius, 20,000 lines to the inch. The iron lines given as standards by Fabry and Buisson were used as fiducial lines. The spark spectra were examined to determine if any changes of wave-length were produced by variations of self-induction and capacity. The conclusion is that there is no determinable shift between arc and spark lines, or between spark lines subjected to different circuit conditions. C. P. B.

73. *Asymmetric Triplets in the Spectrum of Tungsten.* J. Stock. (Phys. Zeitschr. 10. pp. 694-697, Oct. 15, 1909.)—The asymmetry of some of the Zeeman triplets in the spectrum of tungsten has already been pointed out by Jack, and it was suggested that the asymmetry was to be explained by the angle between the plane of polarisation and the rulings on the grating. The author has now reinvestigated the problem, and finds that the rotation of the plane of polarisation by a quartz plate of variable thickness makes no difference. It seems from the present results that there is no pronounced asymmetry present at all, but, under certain conditions, the outside components become diffused upon the side nearer the red. This effect at once

makes the triplet appear asymmetric; but if the outer components are measured from their sharp edges, then it is seen that the asymmetry is only apparent. The explanation of the lines being badly defined on their edges nearer the red is not clear, but the cause undoubtedly lies in the light source, and has nothing to do with the angle between the plane of polarisation and the grating rulings. E. C. C. B.

74. *Change in Wave-length of the Middle Line of a Magnetic Triplet.* P. Zeeman. (Archives Néerlandaises, 14, 3 and 4, pp. 267-277, 1909.)—By the use of an echelon grating which, together with the slit of the collimator, was set horizontally, i.e., at right angles to the slit of the auxiliary spectroscope, the author has confirmed the observation that the middle line of the triplet ($\text{Hg } \lambda = 5791$) is shifted towards the red in reference to the original position of the original line. No such shift is observable with $\text{Hg } \lambda = 5770$. Measurements of the displacement were made with a Fabry and Perot Etalon. E. C. C. B.

75. *Asymmetry in the Zeeman-effect: Banded Emission Spectra of Vapours.* A. Dufour. (Comptes Rendus, 149, pp. 917-919, Nov. 22, 1909.)—A continuation of the author's researches in the asymmetric magnetic resolution of certain band spectra. The compounds studied were the halogen salts of Ca and Sr, and it was found that the heads of three bands are resolved into both a positive and a negative doublet, and one of them also gave a portion unaffected by the field. The scale of these magnetic doublets appears to be in simple relation to the normal scale. [See also Abstract No. 1221 (1909).] E. C. C. B.

76. *Zeeman-effect in Oblique Field.* H. A. Lorentz. (Konink. Akad. Wetensch. Amsterdam, Proc. 12, pp. 821-840, Nov. 25, 1909.)—Certain phenomena observed by Hale in sun-spot spectra induced the present author to work out the theory of the Zeeman-effect on the assumption that the direction of observation is oblique to the lines of force—a problem already treated by W. Voigt [see Abstract No. 1018 (1900)], but in which some details remained to be examined. The subject here treated is the "inverse" effect, to which the direct one is intimately related, and the discussion starts with the fundamental equation in the form in which the author gave it in the "Mathematische Encyclopädie," supposing the magnetic field to be homogeneous and parallel to the axis of z . Though, on account of the complexity of its structure, the modes of motion of the electrons in a particle may be far from simple, it is found possible to treat them mathematically in a general way. This is due to the circumstance that, under certain simplifying restrictions, the electromagnetic action exerted by a particle is found to be wholly determined by its electric moment. Hence, in considering the influence of a particle on the propagation of light, it is possible to replace it by a single electron, to which may be assigned an arbitrarily chosen charge e , and whose displacements, x , y , and z , have such values that the products ex , ey , and ez are equal to the component electric moments of the particle. This imaginary electron may be called the "equivalent electron." Mathematical expressions for the oblique field at angle θ are then derived, which, on putting $\theta = 0$ or $\pi/2$, reduce to those of the well-known theory of the Zeeman-effect for directions parallel to or perpendicular to the lines of force. Certain special cases are also discussed. E. H. B.

77. Luminescence and Crystalline Form of Potassium Sodium Sulphate. B. A. Lindener. (Acad. Sci. St. Pétersbourg, Bull. 14. pp. 961-986, Oct. 15, 1909.)—The author has studied the various kinds of luminescence exhibited by, and the crystalline form of, the double sulphate of potassium and sodium. When crystals of the double sulphate separate from the mother-liquor containing the two sulphates, the separation is always accompanied by luminescence, which may be observed repeatedly with one and the same solution; but if the separated crystals are dissolved in water, luminescence is not, as a rule, produced on crystallisation of the solution thus obtained. The intensity of the luminescence occurring when the double sulphate separates, either alone or mixed with sodium sulphate, varies with the concentration of the solution. The relative proportions of the two alkali sulphates also influence the luminescence, which is very slight with pure solutions of the double salt, $5K_2SO_4$, Na_2SO_4 , $10H_2O$, and reaches its maximum intensity for a solution containing $2.5-2K_2SO_4$ and $1Na_2SO_4$, $10H_2O$. The luminescence is also more marked on the separation of well-developed crystals, being sometimes apparent in daylight. Luminescence is observed only after the deposition of a certain amount of the crystals, the separation of each crystal being then accompanied by a spark, this process being capable of continuing for 8 hours. The luminescence produced by shaking the crystals—triboluminescence—may be observed for some days after the crystallo-luminescence has ceased. Very intense triboluminescence occurs when a glass rod or other hard substance is drawn over the crystalline magma beneath the mother-liquor. Sparks are also observed when the crystals of the double sulphate are either heated or cooled—a phenomenon to which the author gives the name pyroluminescence. The thermoluminescence exhibited by certain minerals may also be due to the change of temperature and not merely to the heating. A parallelism exists between the pyroelectrical properties and the pyroluminescence.

78. Kathode and Anode Luminescence of Organic Substances. A. Pochettino. (Accad. Lincei, Atti, 18. pp. 858-865, Nov. 7, 1909.)—The cathode and anode luminescence of anthracene, phenanthrene, alizarin, phthalic anhydride, α -naphthol, α - and β -naphthylamine, naphthalene, vaseline, and a number of other organic compounds is described. No trace of polarisation could be detected with anthracene, phenanthrene, phthalic anhydride, or α -naphthylamine. It is concluded that the state of aggregation has a marked influence on the colour of the cathode luminescence, which for almost all the substances examined is different at the moment of fusion from that shown by the solid substance—a phenomenon which cannot be attributed to any chemical change, since, on solidification and again exposing to the cathode rays, the luminescence has the original colour. The change in colour of luminescence as the tube is being evacuated is described for some of the substances.

79. Fluorescence and Ionisation of Mercury Vapour. W. Stenbing. (Phys. Zeitschr. 10. pp. 787-798; Discussion, p. 798, Nov. 10, 1909. Paper read before the Versammlung Deutsch. Naturforscher u. Ärzte, Salzburg, Sept. 20, 1909. Deutsch. Phys. Gesell., Verh. 11. 21. pp. 561-578, Nov. 15, 1909.)—The author has observed the fluorescence, absorption, and electrical conductivity of Hg vapour, and shows that the fluorescing vapour is ionised. Along with negative electrons positive "rest-atoms" are also present.

B. H. E.

E. C. C. B.

189. *Electrical Behaviour of Fluorescing Iodine Vapour.* R. Whiddington. (Cambridge Phil. Soc., Proc. 15, p. 189, Nov. 19, 1909.)—An experiment is described in which a beam of arc light was focussed on copper electrodes, 8 cm. apart and connected, one to earth and the other to a gold-leaf electroscope. The fluorescence of the iodine vapour in which the electrodes was placed was observed, but no trace of ionisation could be detected even when the applied field was almost enough to produce a discharge. This is held to show that ionisation is not necessarily an accompaniment of fluorescence.

L. H. W.

81. *Phenomena of Röntgen-ray Transmission.* C. G. Barkla. (Cambridge Phil. Soc., Proc. 15, pp. 267-268, Nov. 19, 1909.)—A general discussion is given of the whole subject of Röntgen-ray transmission, showing the connection between the various phenomena. There is an intimate connection between the absorption of a primary radiation in a substance, the ionisation in the absorbing substance (when in the gaseous state), and the intensity of secondary radiation from the absorbing substance. These are periodic functions of the penetrating power of the primary radiation, the three rising and falling together. Though two complete periods have not yet been obtained in any one substance, there is very strong evidence from the behaviour of different substances that there are at least several maxima and minima to be obtained by using a primary radiation of sufficient range in penetrating power. Experiment shows that there are various characteristic radiations, various ionisations, and various processes of absorption. It is owing to the fact that absorption, ionisation, and secondary radiation connected with one substance are periodic functions of the absorbability of the primary radiation, that these three quantities are also periodic functions of the atomic weight of the substance subjected to a fixed primary beam. If an electromagnetic pulse in which the electric force is uniform from front to back of the pulse, passed over a number of independent electrons with a definite period of vibration, the absorption would be a periodic function of the thickness of the primary pulse. With a primary pulse in which the force gradually changes from zero to a maximum, and gradually again to zero, the periodicity and the absorption of thicker pulses would practically disappear. In such a case the periodicity would have to be explained by assuming the existence of different absorbing, radiating, and ionisable systems in the same atom. The connection between absorption, ionisation, and intensity of secondary radiation might be easily accounted for. It would only be after such an absorption of energy that electrons would be hurled out of an atom, and ionisation be produced—both as a primary and secondary or subsequent effect of this ejection. The disturbance of the atom would set up an electromagnetic pulse characteristic of the atom. It seems very improbable for several reasons that the subsequent bombardment of other atoms by the ejected electrons produces an appreciable secondary Röntgen radiation. The most difficult point to explain is the fact that the primary radiation must be just more penetrating than the homogeneous secondary radiation characteristic of the exposed substance for that radiation to be excited. This law appears to be an extension of Stokes' law of fluorescence to which the phenomenon of the secondary characteristic radiation is akin. The exactness with which the law is obeyed, and the striking similarity between the various absorption curves, indicates a definiteness in the structure of the pulses, and the absence of anything corresponding to variation in pulse structure.

J. J. S.

82. *Secondary Kathode Rays.* C. D. Cooksey. (Nature, 63, p. 128, Dec. 2, 1909.)—It has been previously noted that for the corpuscular rays produced in metals by Röntgen rays, there is a lack of symmetry between those coming from the side of the metals on which the primary rays are incident and those coming from the emergence side. The ionisation produced by the emergence secondary corpuscles was found to be greater than that produced by the incidence corpuscles. Further experiments have been carried out to find if this lack of symmetry was dependent on the penetrating power of the primary Röntgen rays. The metals tested were gold and silver, and it appears that there is a slight variation of the asymmetry with the hardness of the Röntgen rays, certainly in the case of silver, and very probably in the case of gold, the harder primary rays causing the ratio of the emergence to the incidence corpuscular rays to increase. J. J. S.

83. *Scattering of β -rays from Radium by Air.* J. A. Crowther. (Cambridge Phil. Soc., Proc. 15, pp. 278-274, Nov. 19, 1909.)—A preliminary account of experiments on the scattering of a beam of β -rays from Ra during its passage through air. A pencil of β -rays is spread out into a magnetic spectrum, a portion of which, consisting of rays having a definite small range of velocities, falls on a small aperture in a lead screen. The rays passing through this aperture are further limited by a second screen, so as to form a narrow divergent pencil of small angle consisting of rays of very nearly the same velocity. The intensity of the β -radiation passing through the geometrical cross-section of this pencil at various distances from the origin, is measured by the ionisation produced in an ionisation chamber. From the table of results given it can be seen that the coefficient of scattering of the rays varies rather more rapidly than the inverse 4th power of their velocity. This is probably due to the increase in the electrical mass of the β -corpuscles with increasing velocity. [See also Abstract No. 792 (1908).] A. E. G.

84. *Relation between Uranium and Radium.* F. Soddy. (Phil. Mag. 18, pp. 846-858, Dec., 1909. Paper read before the Physical Soc., Oct. 22, 1909.)—A full account of the experimental methods is now given [see Abstract No. 1288 (1909)]. It is found that the growth of Ra proceeds according to the square of the time. On the assumption that no other intermediate bodies intervene the period of the direct parent of Ra is 18,500 years. The amount of Ra present in the last prepared solution is less than that to be expected; this suggests the existence of at least one new product, "Uranium A," intermediate between UrX and the parent of Ra, with a period of the order of 1 year. It is concluded that this would not appreciably alter the production of Ra according to the square of the time over the period observations have been made, but it would vitiate the calculations of the period of the average life of the parent of Ra according to the Rutherford formula. A. E. G.

85. *Scattering of the β -Rays of Radium.* J. P. V. Madsen. (Roy. Soc. S. Australia, Trans. Vol. 88, 1909. Phil. Mag. 18, pp. 909-915, Dec., 1909.)—The present paper aims at ascertaining whether any parallel can be drawn between the effects of scattering in the case of the material β -particles and the γ -rays. The apparatus used is fully described, and curves are given illustrating the results obtained. It is concluded that the experiments with the β -rays of Ra support the results obtained by Crowther, using Ur, upon

the scattering of the rays by thin films of material [see Abstract No. 792 (1908)]. The distribution of the scattered β -rays is unsymmetrical about a plane at right angles to the direction of the original stream. A close parallel thus exists between the scattering of the β -rays and that of the γ -rays and Röntgen rays. The experiments show that the shape of the so-called absorption curve may be modified by the shape of the ionisation chamber and the position of the screen and active material relatively to the chamber and to each other. Absorption of a beam of β -rays, combined with the effects of scattering and softening, seem sufficient to account for observed effects without the introduction of the idea of a true secondary radiation proceeding from the atoms affected by the primary stream of rays. An electron appears to be able to suffer collisions, producing considerable change in its direction of motion, without any great loss of energy. A. E. G.

86. *Emission of Röntgen Rays from Thin Metallic Sheets.* G. W. C. Kaye. (Cambridge Phil. Soc., Proc. 15, pp. 269-272, Nov. 19, 1909.)—In these preliminary experiments, Al, Cu, Au, and Pt-leaf are used for antikathodes. The results obtained indicate that, generally speaking, the emergence Röntgen radiation from a thin metal antikathode exceeds the incidence in intensity. This is most marked in the case of Al. Furthermore, as evidenced by the phosphorescence of the glass walls of the tubes, the accompanying emergence secondary kathode radiation from the antikathode is more intense than the incidence kathode radiation. As far as can be judged, the ratio of the intensity of emergent to incident radiation (R) for kathode rays seems to follow any variation of " R " for the Röntgen rays. With heterogeneous kathode rays the incidence beam of Röntgen rays is softer than the emergence. The ratio " R " increases with the speed of the impinging kathode rays, provided the antikathode is thick enough. For each thickness of the antikathode there is a certain speed of kathode rays which gives a max. value to the ratio R . The ratio drops in amount for greater or less speeds than this. As the thickness of the antikathode increases, the emergence intensity (for the same speed of kathode ray) first increases to a maximum and then dies away; the incidence intensity meanwhile gradually increases to a constant value. [See also Abstracts Nos. 466, 651, and 1226 (1909), and preceding Abstract.] A. E. G.

87. *Penetrating Radiation in the Atmosphere.* K. Kurz. (Phys. Zeitschr. 10, pp. 834-844; Discussion, pp. 844-845, Nov. 10, 1909. Paper read before the Versamml. Deutsch. Naturforscher u. Ärzte, Salzburg, Sept. 22, 1909. Deutsch. Phys. Gesell., Verh. 11. 21, pp. 624-647, Nov. 15, 1909.)—The author discusses the results of other workers and many other researches, and arrives at the following conclusions: (1) The assumption of an ultra-terrestrial source for the observed radiation of high penetrating power in the lowest layers of the atmosphere is impossible; for in its consequences it contradicts completely the observed relation between the ionisation and conductivity at different altitudes. (2) The radio-active material in the atmosphere gives out a radiation of high penetrating power; but the intensity of this radiation is only about 1 per cent. of the penetrating radiation observed in the lower layers of the atmosphere. (3) The radio-active material in the upper layers of the earth's crust proves itself, on the other hand, to be the necessary and sufficient cause of the radiation; it gives out γ -radiation quantitatively equal to the penetrating radiation in the lower

layers of the atmosphere. (4) The radio-active material of the earth's crust furnishes radiation whose magnitude is essentially constant; the radio-active material of the atmosphere gives rise to the periodic variations of the total amount of the radiation in the atmosphere. A. W.

88. *Radio-activity and Rocks.* F. P. Mennell. (Nature, 82, pp. 68-69, Nov. 18, 1909.)—Pleochroic halos may be regarded as due to α -particles emitted by radio-active substances. Zircon, orthite (allanite), epidote, sphene, and apatite are capable of producing halos when enclosed in suitable substances. It appears as if the activity of the above minerals may be fairly attributed to the presence of Th. The radio-activity of Th is considered a more potent factor from a geological point of view than that of Ur and its derivatives, because of the much wider distribution of the former than the latter. R. J. Strutt. (Ibid. p. 98, Nov. 25, 1909.) A. E. G.

89. *Accumulation of Helium in Geological Time.* H. R. J. Strutt. (Roy. Soc., Proc. Ser. A. 88, pp. 96-99, Dec. 10, 1909.)—A table is given showing the "helium ratio" (He in c.cm. per gm. of total equivalent U_3O_8 , that is to say, the quantity of $U_3O_8 + 0.208$ times the quantity of thorium present) for various minerals. Each unit in this ratio represents 11 million years. The helium ratio ranges from 0.87 up to 18.2 for haematite from different localities. [See Abstract No. 1758 (1908).] L. H. W.

REFERENCES.

90. *Propagation of Light in a Moving Dielectric Medium.* A. Scheye. (Ann. d. Physik, 30. 4. pp. 805-814, Nov. 30, 1909.)—A mathematical treatment.

91. *Diffraction Thermodynamically Considered.* M. Laue. (Phys. Zeitschr. 10. pp. 807-810; Discussion, pp. 810-811, Nov. 10, 1909. Paper read before the Versamml. Deutsch. Naturforscher u. Ärzte, Salzburg, Sept. 21, 1909.)—Discusses the theory of diffraction of heat-rays from the point of view of entropy and other thermodynamic considerations. [See also Abstracts Nos. 1446 (1900) and 1872 (1907).] E. H. B.

92. *Nature and Constitution of Radiation.* A. Einstein. (Phys. Zeitschr. 10. pp. 817-825; Discussion, pp. 825-826, Nov. 10, 1909. Paper read before the Versamml. Deutsch. Naturforscher u. Ärzte, Salzburg, Sept. 21, 1909. Deutsch. Phys. Gesell., Verh. 11. 20. pp. 482-500, Oct. 30, 1909.)—An able résumé of the development of the views held by physicists as to the nature and constitution of light and radiation generally. Beginning with the inference from interference and diffraction that light is a wave-motion, and in the ether, since a vacuum is no bar to it, the author ranges on to the most recent modern views. E. H. B.

93. *Transformation of Energy in Radiation.* F. Hasenöhr. (Phys. Zeitschr. 10. pp. 829-880; Discussion, p. 880, Nov. 10, 1909. Paper read before the Versamml. Deutsch. Naturforscher u. Ärzte, Salzburg, Sept. 21, 1909.)—Deals with the transformations of kinetic energy in three concrete cases, viz., (1) a reflecting sphere of radius large compared with the wave-length, (2) a reflecting sphere of radius small compared with the wave-length, (3) a free electron. E. H. B.

94. *Light near a Focal Point or Line.* P. Debye. (Ann. d. Physik, 80. 4. pp. 755-776, Nov. 80, 1909. Inst. für theoret. Physik, München.)—In continuation of previous work by F. Reiche [see Abstracts Nos. 1036, 1896 (1909)] the present author here discusses mathematically, on the basis of Huyghens' principle and the electromagnetic theory, the behaviour of light waves, spherical and cylindrical, near their respective focal points and focal lines. E. H. B.

95. *Comparison Prisms for Spectra.* H. Konen. (Astrophys. Journ. 80. p. 318, Nov., 1909.)—In reply to an article by Bell [Abstract No. 1561 (1909)] it is pointed out that the form there suggested would involve the objectionable feature of unequal illumination of the collimator objective. C. P. B.

96. *Homogeneity of Optical Glass.* W. Zschokke. (Zeitschr. Instrumentenk. 29. pp. 286-289, Sept., 1909.)—Examination of various specimens of optical glass for variations of refractive index, with examples of the differences found. C. P. B.

97. *Reflection of Light at a Moving Plane Mirror.* H. Bateman. (Phil. Mag. 18. pp. 890-895, Dec., 1909.)—A mathematical contribution to the work done on this subject by Voigt, Lodge, and others [see Abstracts Nos. 1065 (1909), 2147 (1904)]. By supposing that the image of an object is derived by means of a given space-time transformation, the laws of reflection as stated by Einstein and Hicks may be obtained in a simple way. G. E. A.

98. *Irregular Solar Refraction.* W. H. Julius. (Konink. Akad. Wetensch. Amsterdam, Proc. 12. pp. 266-284, Oct. 28, 1909.)—Experiments are described illustrating the various appearances produced by irregular refraction through, say, drops of salt solution suspended in glycerine. The curving of rays by passing through layers of varying refractive power is considered to have some bearing on the explanation of various solar phenomena. C. P. B.

99. *Electrochemistry of Light.* VIII. *Theory of Solarisation.* Part II. W. D. Bancroft. (Journ. Phys. Chem. 13. pp. 558-578, Oct., 1909.)—A continuation of the discussion of the results of various authors with reference to the reversal of the photographic image [see Abstract No. 1582 (1909)]. T. H. P.

100. *Correction of 80-cm. Objective at Potsdam.* J. Hartmann. (Zeitschr. Instrumentenk. 29. pp. 217-232, July, 1909. Astrophys. Observatorium, Potsdam, March, 1909.)—Analysis of the great Potsdam Steinheil refractor by means of the author's system of extra-focal images, with a series of apertures in front of the objective to register the zonal errors. Two photographs are given showing the results. C. P. B.

101. *New Lines in Calcium Spectrum.* J. Barnes. (Astrophys. Journ. 80. pp. 14-19, July, 1909.)—In continuation of former work [see Abstracts Nos. 1417 (1908), 569, 917 (1908)] the author gives the wave-lengths of the lines in a series of new triplets observed in the calcium spectrum and in several other bands. A few extra weak lines were recorded when metallic Ca was used for the poles; the wave-lengths of these will be given later. C. P. B.

102. *Wave-length Measurements in the Red Region of Spark Spectra.* J. M. Eder and E. Valenta. (Akad. Wiss. Wien, Sitz. Ber. 118. 2a. pp. 511-524, April, 1909.)—Measurements in reference to Rowland's standard scale of the red region of the spark spectra of the following elements: Al, Sb, Ba, Pb, Cd, Ca, Fe, In, Cu, La, Li, Mn, Mo, Sr, Ti, and V. E. C. C. B.

103. *Arc Spectrum of Vanadium.* H. Shaw. (*Astrophys. Journ.* 30. pp. 127-134, Sept., 1909.)—Tables of vanadium arc lines in the red region from 5799.96 to 7868.80, reduced from photographs taken with a Littrow prism spectrograph and a concave Rowland grating spectrograph. Vanadium sulphate or chloride was volatilised on carbon poles, using a current of 8-12 amps. The determinations of wave-length were obtained by means of a comparison spectrum of iron photographed on the same plates. C. P. B.

104. *Spontaneous Luminosity of Uranite (Autunite).* R. J. Strutt. (*Roy. Soc., Proc. Ser. A.* 83. pp. 70-71, Nov. 4, 1909.)

105. *Spark-spectra of Potassium and Sodium.* R. Schillinger. (*Akad. Wiss. Wien, Sitz. Ber.* 118. 2a. pp. 605-627, May, 1909. From the photochem. Laborat. d. k.k. Graphischen Lehr- u. Versuchsanstalt, Wien.)—An accurate measurement of the wave-lengths of the lines of the spark spectra of K and Na in a hydrogen atmosphere between the limits $\lambda=2100$ and $\lambda=7700$. E. C. C. B.

106. *Influence of Dilution on Colour and Absorption Spectra of Permanganates.* J. E. Purvis. (*Cambridge Phil. Soc., Proc.* 15. pp. 247-256, Nov. 19, 1909.)

107. *Separation of the Spectral Lines of Thorium in the Magnetic Field.* B. E. Moore. (*Astrophys. Journ.* 30. pp. 144-166, Sept., and pp. 178-221, Oct., 1909.)—An account of a very complete examination of the magnetic resolution of the lines of Th. E. C. C. B.

108. *Spectral Map of the Mercury Arc Lamp in the Ultra-violet.* W. Hallwachs. (*Ann. d. Physik.* 30. 3. pp. 598-601, Nov. 4, 1909.)—The paper contains photographs of the ultra-violet region of the Hg arc-lamp spectrum taken on bromide paper with different exposures and also coloured maps of the whole arc spectra of Li, Na, and Ba suitable for lecture purposes. E. C. C. B.

heat distribution is uniform. Consequently the freezing-point is more easily observed, but it is more liable than the melting-point to hysteresis. Literature citations in heat distribution give rise to opportunities for interpretation, and are caused by imperfect contact of the thermoelement with the charge, or by the thermoelement not being in contact with the charge. These possibilities can be avoided by the charge rather than the element.

HEAT.

109. *Melting-point Methods at High Temperatures.* W. P. White. (Amer. Journ. Sci. 28, pp. 474-489, Nov., 1909.)—Temperature measurements are most effectively made by means of Pt—Pt-Rh couples combined with a potentiometer arrangement, frequent standardisation being necessary on account of the ease with which the couples become contaminated. Platinum resistance furnaces, efficiently lagged, give the most effective means of heating, since the temperatures can easily be controlled, and, by modifying the working chamber, uniformity of heat distribution can be obtained. Small charges allow of easy manipulation and give very sharp melting-points. A knowledge of the source of heat often becomes necessary, and is obtained by placing a second thermo-element in the furnace so as to indicate the actual furnace temperature in the region of the charge. In making a determination of a melting-point it is necessary to take readings of the temperature of the charge and the control element every minute, and to keep the difference in temperature constant by cutting out resistance from the heating circuit, if accuracy is desired. When the melting is subject to hysteresis, as in the case of viscous substances, slow heating and frequent examination of the charge must be resorted to. A melting-point determination can be conducted so as to have, within certain limits, a calorimetric interpretation, but there are many sources of error, and at present the method of mixtures is the only accurate calorimetric method at high temperatures. For determining feeble thermal changes in the solid, large charges, rapid heating and uniform heat-distribution are essential. [See next Abstract.] F. C. A. H. L.

110. *Melting-point Determinations.* W. P. White. (Amer. Journ. Sci. 28, pp. 458-473, Nov., 1909.)—In the ideal melting-curve there is an interval of constant temperature, but an actual curve is oblique, i.e., the melting interval is denoted by a line which rises continually between temperature intervals which may be as great as 80° C. This obliquity is influenced by a variety of factors, such as hysteresis of melting, met with in certain feldspars, but is mainly caused by the presence of impurity. The true temperature of melting is given by the upper limit of the melting interval. Since the melting-point depression caused by impurity is proportional to the square of the absolute temperature, the effect on the obliquity of the curve increases rapidly with the temperature. During melting the rise in temperature of the charge is checked, while the furnace temperature is increasing, and thus the temperature gap between the furnace and charge increases towards the end of melting, resulting in an increase of obliquity. A similar increase of obliquity occurs at the end of a freezing interval. Heat distribution largely affects the obliquity, e.g., there is an inevitable temperature-difference between the inside and outside of a charge, especially where large charges are used, and this uneven heat-distribution retards the temperature-rise at the beginning of melting and increases it at the end, where obliquity is most undesirable. With large charges, the increase in obliquity is often sufficient to mask the break in the curve indicating the end of melting. The true freezing-point comes at the beginning of the freezing interval, when the

heat distribution is uniform. Consequently the freezing-point is more easily observed, but is more liable than the melting-point to hysteresis. Irregular variations in heat distribution give rise to obliquities uncertain of interpretation, and are caused by imperfect centring of the thermo-element, conduction of heat by the thermo-element, and the tendency for melting to start from the ends of the charge rather than the sides. These irregularities can be avoided by using fine wires and narrow charges. By taking advantage of these precautions meltings at above 800°C . have been made agreeing with each other to 0.05° , but there still persists a small experimental obliquity of 0.5° to 1.5° , the cause of which has still to be determined. F. C. A. H. L.

111. *Experiments on Evaporation.* A. Naccari. (Accad. Sci. Torino, Atti, 44. 14. pp. 561-572, 1908-1909.)—Winkelmänn [Wied. Annalen, 22. p. 1, 1884, and 33. p. 445, 1889] gave the following modification of Stefan's evaporation formula [Wiener Berichte, 68. 2. 1878; 98. 2. p. 1418, 1889]—

$$v = k/h(1 + a\theta) \cdot \log [(P - f)/(P - F)],$$
 in which v represents the volume, reduced to normal conditions, of the vapour given off in 1 sec. from 1 cm.² of surface of the liquid, P the atmospheric pressure, F the max. pressure of the vapour at the temperature θ of the experiment, f the pressure of the vapour in the space above the mouth of the vessel, h the distance of the surface of the liquid from the mouth of the vessel, which has vertical walls, and k the coefficient of diffusion of the vapour into the air at the normal pressure and at the temperature θ of the experiment; if the space into which the vapour issues is large, f becomes zero. The author's experiments with ether show that the value of k increases with h , as was found by Winkelmänn to be the case with water and with alcohol. Measurements at different temperatures show that the value of k is expressed very approximately by the formula $9.981 \times 10^{-7} T^2$, T being the absolute value of the temperature θ . Electrification of the liquid to potentials up to 1,700 volts appears to be without influence on the evaporation. Attempts to verify experimentally Stefan's theoretical deduction, that the quantity of liquid evaporated from a circular basin in a given time is proportional to the periphery, rather than to the superficial area of the basin, gave no definite results, owing to the difficulty of rendering the conditions constant for different basins.

T. H. P.

112. *Kinetic Theory of Matter.* O. W. Richardson. (Phil. Mag. 18. pp. 695-698, Nov., 1909.)—It was stated in a paper by Richardson and Brown [see Abstract No. 1825 (1908)] that $F(u)du = 2kmv \cdot \frac{1}{2}mv^2 du$, where $F(u)du$ is the probability that a molecule leaving any surface in a gas should have a velocity component perpendicular to that surface which lies between u and $u + du$, m representing the mass of the molecules and $\frac{1}{2}mv^2$ their mean translational kinetic energy. This formula is here deduced from a more familiar one. Then, by the aid of results previously obtained [see Abstract No. 1489 (1904)], a simple proof is obtained of the known theorem that the distribution, among the particles leaving any surface, is independent of the amount of work done by the particles in crossing the surface, including the usual case where the work has the particular value zero. It is pointed out that this result, which has been shown to be applicable to thermionics, is equally applicable to ordinary molecular evaporation. It follows as a special case that the molecules escaping from a liquid by evaporation will be in complete

statistical equilibrium with those in the surrounding vapour. The author points out, further, that both this application and the applications to thermionics are particular examples of the general theorem (Jeans' Dynamical Theory of Gases, p. 78) that the mode of distribution of kinetic energy among the ultimate particles of a system is independent of the potential energy of the part of the system in which they occur. G. W. DE T.

113. *Molecular Kinetic Energy and Absolute Temperature.* M. Brillouin. (Annal. Chim. Phys. 18. pp. 887-400, Nov., 1909.)—The paper contains a mathematical examination of various hypotheses which suggest themselves as likely to afford a basis for the representation of the absolute temperature of dense isotropic bodies in terms of the molecular kinetic energy. It is pointed out that the law of Dulong and Petit and its developments find their most natural expression in the form—the specific heat at constant configuration does not contain any negative powers of the absolute temperature T ; the term independent of T , expressed in terms of atomic mass, is a universal constant, and therefore independent of the configuration. After examining various hypotheses, the author concludes that the only satisfactory one is represented by the equation $(1 + bE) = aT$, where E is the mean kinetic energy of a molecule, b is a function of the co-ordinates only, and a is a constant. This hypothesis leads to an expression for the law of compressibility derived from the virial, which has for denominator, as required by experiment, a function of the volume. All previous attempts to develop a kinetic theory, whether by aid of the virial or by means of statistical mechanics, have led only to an expansion in integral powers, in which case a denominator does not appear in the expression. [It is of interest to note that the author's argument confirms the conclusion recently deduced by Jeans from the electron theory [see Abstract No. 1268 (1909)] that the absolute temperature of a solid cannot be defined, like that of a gas, by the mean kinetic energy of translation of its molecules.] G. W. DE T.

114. *Definition of an Ideal Gas.* A. G. Webster and M. A. Rosanoff. (Phys. Rev. 29. pp. 804-809, Sept., 1909. Paper read before the Amer. Physical Soc., Oct. 24, 1908.)—The authors examine the various definitions which have been given for an ideal gas in order to ascertain to what extent they are identical. The conclusion is drawn that the correct definition is that given by Buckingham [Abstract No. 1869 (1907)], namely, the ideal gas is one which follows Boyle's law and in which a free expansion, with no external work, would cause no change in the temperature; this criterion is tested by means of the Joule-Kelvin porous plug experiment. Consideration of the three equations—

$$I., p\bar{v} = RT; \quad II., p_c = T(\partial p / \partial T)_v - p = 0; \quad III., C_p K = T(\partial v / \partial T)_p - v = 0,$$

shows that if I. is true, so also are II. and III. Hence I. is a sufficient definition of an ideal gas, but it involves the previous knowledge of the absolute temperature. Either of the equations II. and III. involves the other, and, further, the product $p\bar{v}$ does measure the absolute temperature, so that Buckingham's definition is both necessary and sufficient and defines the absolute temperature, but it may be replaced by the equivalent specification of Boyle's law, and no cohesion, or, what is the same thing, the energy depends wholly on the temperature. Finally, disregarding the gas laws, integration of II. on the assumption that v is constant gives $T/p = g(v)$; such

a gas is suitable for measuring the absolute temperature on a constant-volume thermometer, but it will not, in general, have a zero Joule-Kelvin effect. In like manner, integration of III. on the hypothesis $p = \text{const.}$ yields $T/\epsilon = h(p)$, a gas answering this condition being suited to measure the absolute temperature on a constant-pressure thermometer, although in general its energy is dependent on the volume or pressure as well as on the temperature. The vanishing of the Joule-Kelvin effect in the porous plug experiment is not a test of absence of cohesion, unless the gas is ideal, and conversely.

T. H. P.

115. *The Constant in Stefan's Law.* E. Bauer and M. Moulin. (Comptes Rendus, 149. pp. 988-990, Nov. 29, 1909.)—The energy, E , radiated per sec. per unit area of a black body is connected with the absolute temperature T of the body by the law $E = \sigma T^4$, where σ is a constant for which Kurlbaum found the value 5.82×10^{-10} and Féry 6.8×10^{-10} . The authors have re-determined the constant, standardising the conical receiver of the rays by means of radiation carrying a known quantity of energy. The value of RI^2/S for a Pt plate, heated in a vacuum, of resistance R and area S , through which a current I was passed, was plotted against R . The plate was then placed vertically and heated in air, and the e.m.f. ϵ , of the conical junction of a Féry pyrheliometer-telescope determined when pointed at the hot plate, and the $\epsilon-R$ curve drawn. From these two curves a third one was deduced, representing RI^2/S in terms of ϵ ; this was a straight line. Finally, by directing the telescope at a furnace at 1064°C. , the e.m.f. was observed which was produced by a power of 19.1 watts per unit of area. From these data the value $\sigma = 6.0 \times 10^{-10}$ watts per cm.^2 per 1° was obtained, the accuracy being nearly 1 in 100.

G. E. A.

116. *Measurement of Vapour Pressure.* A. C. Cumming. (Chem. Soc., Journ. 95. pp. 1772-1777, Nov., 1909.)—The author describes a method for determining vapour pressures, based upon that of Lescœur, in which the measurement really amounts to a determination of the dew-point of the vapour in equilibrium with the solution or hydrate. The results obtained with varying strengths of sulphuric acid show very good agreement with those of Regnault and of Lovel; they further show that the method is capable of high accuracy, and, owing to its extreme simplicity, is preferable to the differential tensimeter used by Frowein for determining the vapour pressures of hydrated salts.

F. J. B.

117. *Relation between the Ordinary and the Canonical Form of the Equation of State.* A. Wassmuth. (Ann. d. Physik, 80. 2. pp. 881-892, Oct. 14, 1909.)—Planck [Abstract No. 1455 (1909)] has pointed out that those equations—which he terms "canonical"—which give the entropy S as a function of the energy E and the volume V possess a fundamental advantage over the ordinary forms, in which the pressure p appears as a function of the temperature T and the volume V ; from the canonical form, Planck derived a form similar to van der Waals' equation of state. The author has investigated the assumptions to be made to arrive at a formula $S = f(E, V)$ from one of the type $p = F(T, V)$. The various equations of state and their fundamental assumptions are discussed. Most of them belong to one class, in which c_p is a function only of T and not of V . The equation of Clausius and also that of Håppel are of another class, the alteration of the specific heat with the volume at constant temperature being a product of two functions, one containing V and the other T .

T. H. P.

SOUND.

118. Amplitude and Intensity of Sound. G. Ercolini. (N. Cimento, 17, pp. 265-279, May-June, 1909.)—In order to determine whether the intensity of a sound is proportional to the amplitude of the oscillation or to its square, several conditions must be satisfied which it is difficult to fulfil in practice. The sound must have a constant wave-form, and must be simple, in the sense of giving a complete interference in the differential tube. In obtaining the sound from electrically-driven tuning-forks the noise of the sparks is eliminated by using one to furnish the current which drives the other. But the best results were obtained with Galton's whistle. So far as they go they indicate that the sound, as perceived by the ear, is loud in proportion to the square of the amplitude of the vibration. E. E. F.

119. Gramophone Experiments. J. G. McKendrick. (Nature, 81, pp. 488-490, Oct. 21, 1909.)—A previous article [see Abstract No. 1421 (1909)] described work with the gramophone as phonautograph which is continued by the experiments here described. The author has at last succeeded in transcribing the vibrations of tones or chords as these are produced by the gramophone; that is to say, during the time that the sounds are given forth. The method is illustrated by a figure showing the whole experimental arrangement in operation. The sounds of the gramophone are carried by a tin tube from the end of the arm of the instrument (to which the horn or trumpet-resonator is usually attached) to a sensitive microphone. The microphone used was by Müller-Uri, of Brunswick, and intended for the singing-arc flame and for a loud-speaking telephone. In the microphone circuit five or six dry cells were placed, also the recorder, which is a very small electromagnet, having a marker attached to a keeper, like the "Deprez-signal" known to physiologists. The electromagnetic recorder acted like a little telephone, and gave a record on the camphor-smoked paper wound on a revolving drum. This drum took at the same time a record from a 100-vibration tuning-fork, so as to register on the tracing hundredths of a second. The smoked tracings were afterwards fixed by clear shellac varnish. Slightly enlarged photographs of portions of these appear in the article. These deal with (1) the Westminster chimes, showing beats after the last stroke; (2) male voices singing the "Soldiers' Chorus" from *Faust* in La Scala Theatre, Milan, showing very complicated curves; (3) Signor Caruso singing "Spirito Gentile," giving fine crescendo and diminuendo effects; (4) the band of the Coldstream Guards playing the overture to *Tannhäuser*, including wide ranges of pitch and some very irregular curves. It was also found that the gramophone could be dispensed with, the singer or speaker using the microphone directly, the whole arrangement forming an excellent phonautograph. About 5 minutes are occupied in taking a tracing 185 ft. long. E. H. B.

120. Small Motion at Nodes of a String. C. V. Raman. (Nature, 82, p. 9, Nov. 4, 1909.)—It is generally recognised that the nodes of a string which is maintained permanently in oscillation in two or more loops cannot be points of absolute rest, as the energy requisite for the maintenance of the vibrations

is transmitted through these points. The small motions at the node may be shown dynamically to differ in phase by a quarter of an oscillation from those of the rest of the string. By attaching a thread to an obliquely-set, electrically-maintained tuning-fork, points of the strings in the loops describe 8-curves, while the so-called nodes describe very flat parabolas, the chief motion being longitudinal. E. H. B.

121. *Perception of Direction of Sound.* Rayleigh. (Roy. Soc., Proc. Ser. A. 88. pp. 61-64, Nov. 3, 1909.)—About three years ago the author experimentally showed that the discrimination of the perception of the direction of sound depends upon the phase-difference at the two ears, and that the sound is judged to be on that side where the phase is in advance [Abstract No. 444 (1907)]. In Jan., 1908, Myers and Wilson published experiments [Abstract No. 1180 (1908)] made by another method, which confirm the general conclusion that phase-differences at the outer ears are recognised by, and give rise to "lateral sensations," but in their view the ultimate cause of the lateral effect is still a difference of intensities at the inner ears which may occur, in spite of equality at the outer ears, in virtue of conduction of sound from one side to the other through the bones of the head. The present author had already tried an experiment in order to see whether a small disturbance of relative intensities at the two ears would upset the judgment of any observer listening in the open. Unknown to him, a piece of board could be introduced near his ear on the same side as the sound, by which it was supposed that the intensity on that side would be reduced, perhaps even below the intensity upon the further side. It was found that no misjudgment of direction could thus be induced. Although not actually conclusive, this result is unfavourable to a theory that would make the lateral sensation dependent upon small differences of intensities. The repetition of the experiments by other observers, and in varied forms, is felt to be desirable. E. H. B.

122. *New Type of Forced Vibrations.* C. V. Raman. (Nature, 82. pp. 156-157, Dec. 9, 1909.)—A. Stephenson (Quarterly Journal of Pure and Applied Mathematics, No. 148, June, 1906) discussed mathematically the proposition as follows: "Periodic non-generating force acting on a system in oscillation about a position of stable equilibrium exerts a cumulative action in intensifying or diminishing the amplitude if its frequency is contained within any one of a number of ranges lying in the vicinity of 2μ , $2\mu/2$, $2\mu/3$, &c., where μ is the natural frequency of the system." Thus the Melde experiment for frequencies as 2:1 is only a special case of the above general theorem. The present author has now found experimental confirmation of some of the other ratios in the series. Thus, with an electrically-maintained tuning-fork oscillating parallel to an attached string the string's oscillations might have a frequency of $\frac{1}{2}$, 1, $8/2$, 2, &c., that of the tuning-fork, each term in the harmonic series appearing separately by itself with a fairly large amplitude, or with one or more of the others conjointly according to circumstances. E. H. B.

REFERENCE.

123. *Reflection of Sound at a Paraboloid.* H. J. Sharpe. (Cambridge Phil. Soc., Proc. 15. pp. 190-197, Nov. 19, 1909.)—Mathematical.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

124. *Motional Effects of Maxwell Ether Stress.* E. Cunningham. (Roy. Soc., Proc. Ser. A. 88. pp. 109-119, Dec. 10, 1909.)—There is an outstanding gap in electromagnetic theory in respect to the attempt to reconcile the analysis of ether stress on the lines initiated by Maxwell with Newton's third law and the law of the conservation of energy. In the present condition of theory there is assigned to the ether a certain distribution of electromagnetic energy and momentum. The hypothetical distribution of energy is necessarily associated with the Poynting vector which measures its rate of transference. The distribution of momentum is so defined that the rate of increase of the total amount, within any given volume supposed at rest in the ether, is equivalent to the resultant of the Maxwell stresses on the bounding surface. There is, however, no connection established between the transference of energy across an area and the stress across that area. Such a connection would require that it should be possible to assign to the medium in which stress and energy reside a state of motion whereby the stresses might do the necessary amount of work, and this again would require the revision of the specification of stress, inasmuch as the ordinary expressions are computed for an element of surface which is at rest. Other questions arise as soon as such a process is attempted, but the present paper seeks only to analyse what type of motion must be looked for, and to specify the field of stress upon elements of area moving with the velocities obtained. Strictly, it is incorrect to speak of the *stresses* on elements of area in the ether at the same point having different velocities. The true stresses in a continuous medium can only be estimated on an area moving with the medium. All that can be done in the absence of a knowledge of the velocity of the medium is to analyse the transference of momentum across an element of area having a specified velocity. Only when this velocity is that of the medium is it legitimate to interpret this transference as due to a state of stress in the medium. Thus, unless the ether is supposed at rest, the Maxwell expressions have no significance, except as giving the rate at which momentum is crossing an element of area at rest. If, however, the ether is assumed at rest, then no state of stress can give rise to any transfer of energy. The matter is then discussed mathematically, vector analysis being used. The total (electric and magnetic) stress on elements of area at rest is treated, also the problem of the moving reflector and plane radiation. It is noteworthy that the result of one part of the treatment is that to an intelligence incapable of appreciating extremely rapid changes, the mechanical properties of the radiation may be described as those of a continuous perfect fluid in which pressure p , energy ϵ , velocity v , and momentum γ , are distributed, the four magnitudes being connected by the relations $p = \frac{1}{2}(\epsilon - v\gamma)$, $\epsilon\gamma = v(\epsilon + p)$, and the vectors v and γ having the same direction. Other results are obtained which suggest an analogy to kinetic theory of gases, equations like $p\bar{v} = \text{constant}$ and $pV = RT$ being derived.

E. H. B.

125. *Electrical State of the Upper Atmosphere.* W. Makower, M. White, and E. Marsden. (Inst. Elect. Engin., Journ. 43. p. 216, Aug., 1909. Paper read before the Manchester Section.)—The current flowing down a wire suspended by a kite at altitudes 2000–6000 ft. at Glossop were found to be of the order 5×10^{-3} to 28×10^{-3} amp. when measured by a dead-beat galvanometer.

L. H. W.

126. *Potential Gradient at Trieste from November, 1902, to March, 1905.* A. Brommer. (Akad. Wiss. Wien, Sitz. Ber. 118. 2a. pp. 629–701, May, 1909.)—The observatory is near the centre of the town, and the effect of dust and smoke must thus be considerable. The observations were made with a Bendorff electrometer fitted with a radium collector placed 4.28 m. above the ground and 1.08 m. above the gutter of the building. The apparatus was placed at the SW. corner of the building, where it was sheltered from the prevailing NE. winds (Bora). The gradient was entirely positive on 51 per cent. of the days, entirely negative on 1 per cent. (8 days, all days of heavy precipitation). Positive gradient prevailed during 92 per cent. of the time of observation. The normal, fine weather gradient is determined from the data for days on which the cloud amount did not exceed 2 (scale 0–10), and the wind velocity 20 km./hour throughout the day. Table I. gives the mean gradient for each month. The mean value for the year is low, 78 volts/m. (Potsdam 242, Wolfenbüttel 221, Kremsmünster 98). The seasonal variation is also small. Maxima occur in winter (primary) and summer, minima in spring (primary) and autumn. Table II. represents the diurnal variation by means of hourly values. Harmonic analysis of the data gives the following: Winter, $y = 84.8 + 48.2 \sin(229^\circ 42' + x.15^\circ) + 8.9 \sin(166^\circ 15' + x.30^\circ)$; $A_1/A_2 = 11.1$; summer, $y = 68.4 + 35.9 \sin(240^\circ 32' + x.15^\circ) + 9.6 \sin(184^\circ 0' + x.30^\circ)$; $A_1/A_2 = 8.7$; whole year, $y = 74.9 + 41.5 \sin(235^\circ 48' + x.15^\circ) + 4.8 \sin(155^\circ 18' + x.30^\circ)$; $A_1/A_2 = 8.65$. The values for the different years are closely concordant. Observations of dissipation are made regularly at noon. The seasonal variation shows maxima at the time of the minima of potential gradient, and *vice versa*. The prevailing wind at Trieste is the Bora, a NE. land wind which often attains great violence. On the average it blows on 94 days in the year. For this wind there is a distinct connection between wind velocity and potential gradient, the latter decreasing from 104 volts/m. for winds of mean velocity 5 km./hour to 60 volts/m. for winds of 65 km./hour. The dissipation shows a corresponding increase. Sea-breezes show no marked connection between wind velocity and potential gradient. The gradient is in general considerably greater than for land winds. The concluding 45 pages of the paper give the hourly values of the potential gradient for each day of the period Nov., 1902, to March, 1905.

R. G. K. L.

127. *Influence of Exposure on the Measurement of Electrical Dissipation and Conductivity.* E. v. Schweidler. (Phys. Zeitschr. 10. pp. 847–849; Discussion, p. 849, Nov. 10, 1909. Paper read before the Versamml. Deutsch. Naturforscher u. Ärzte, Salzburg, Sept. 22, 1909.)—All measurements are supposed made with Elster and Geitel's apparatus. If the apparatus be exposed at a point where the potential differs from zero by V_0 , fluctuations of V_0 may affect an individual measurement of q very seriously, but their effect is negligible if we take the mean of many readings. If V_0 is constant and normal, i.e., positive, a_- will be systematically lowered and a_+ raised, and the values of q are systematically too great. [For observations confirming

this suggestion see Abstract No. 1576 (1909.)] The following additional results of observations made at Seeham (Austria) are given : (a) At the corner of a projecting first-storey balcony $q = 1.88$; (b) 1½ m. nearer the wall, just under the roof, $q = 1.09$; (c) 1 m. nearer the wall than (b), $q = 1.03$. Rough measurements of potential gradient were made simultaneously with the measurements at (c). The results show a steady increase in the values of q from 0.97 to 1.14 with increase of potential. On 86 occasions measurements were made at a point (p) vertically below (c) on a ground-floor verandah, immediately after the observations at (c). At (c) $q = 1.04$, at (p) $q = 1.00$. The results for (p) are influenced only slightly by variations of potential.

R. G. K. L.

DISCHARGE AND OSCILLATIONS.

128. *Positive Electricity.* J. J. Thomson. (Phil. Mag. 18, pp. 821-845, Dec., 1909.)—The most important questions to be settled as to the nature of positive electricity are : (1) Does a definite unit of positive electricity exist? (2) If so, what is the size of the unit? Can we get positively electrified particles of the same kind from different gases? Our knowledge of charged positive particles (other than α -particles) has been derived from two sources, (1) the study of positive particles in systems of positive rays found in vacuum tubes; (2) the study of the velocity of positive ions in ionised gas. The positive rays which have been the most closely studied are the canal rays which are found passing through a perforated kathode, and the rays shot out from the kathode in the same direction as the kathode rays, some of which are charged positively, "retrograde rays," while others are electrically neutral. The deflection of the positive rays by magnetic and electric fields is discussed. An important point as to the determination of e/m is that the values obtained from the magnetic and electric deflections are the average values of e/m whilst the system is in the magnetic and electric fields. Since some of the systems are at times electrically neutral, the average value of e/m cannot be greater than the true value, and it may be considerably less. Now take two magnetic fields, one short but strong, the other long but weak, and adjust the strengths of the fields so that if the positive particle retained its charge the whole of the time it was in either field, the deflection of the particle would be the same in both cases. If the particles whose deflection we are measuring become neutralised in passing through the longer field, the deflection produced by the short field will be greater than that by the long, provided the length of path of the particle when uncharged is comparable with the length of the shorter field. Experiment shows that the max. value of e/m obtained by this method is the ratio of the charge on the particle to its mass, and not the average extending over a time during part of which it is uncharged. Experimental results are described which point to the conclusion that even at the start from the kathode the canal rays include a large number of neutral doublets, if, indeed, they do not wholly consist of them. The presence of neutral doublets is even more marked among the "retrograde rays." These neutral doublets are very interesting, as they form an intermediate stage between the ion and the neutral molecule. They are also found when the electric field is much less intense than when the discharge is produced by the induction coil. The experiment to show this, in which a hot Wehnelt kathode is used, is fully described. The velocity of the neutral doublets in the discharge produced by an induction coil is

approximately the same as that of the positively charged particles which accompany them. The direction of the doublets is approximately that of the lines of force close to the kathode; they may move in either direction along the lines. An experiment is described which shows that the doublets seem to start from beyond the dark space next the kathode. Is the doublet the thing set free from the atom when it is ionised? And are the ions first produced by the splitting up of the doublets, or are the ions first produced and the doublets produced by a combination of the positive and negative ions? There are arguments to be urged in favour of either view. The fact that the direction of projection of these doublets is parallel to the direction of the lines of force at the kathode, points to the projection being due to electrical forces; still there are canal rays whose velocity is but slightly affected by the p.d. between the electrodes of the discharge tubes or the pressure of the gas. An experiment shows that it is very improbable that they owe any considerable part of their velocity to the action of the electric field upon them whilst they approach the kathode. The velocity of the canal-ray particle is considerably less than that of a kathode-ray particle; the energy of the kathode particle is, however, less than that of a particle in the canal rays. Experiments with the "retrograde rays" show that their velocity is also practically independent of the strength of the field and very nearly the same as that of the canal rays. If doublets form an intermediate stage between ions and the atom, the doublets being the systems formed from the molecules of the gas by the ionising agent, then the number of doublets liberated may be enormously greater than the number of ions set free, so that this number may give no indication of the percentage of molecules affected. This point is an important one in connection with the structure of the Röntgen rays, the small percentage of the molecules decomposed has always been difficult to understand. The values of e/m for the canal rays in very different gases is equal to 10^4 . This seems strong evidence that there is a definite unit of positive electricity, the carrier of the positive unit being much larger than the negative, and the positive unit, like the corpuscle, capable of being detached from the molecule of the gas. There are some cases in which the value of e/m for positive ions appears to be greater than 10^4 . Experiments described, however, indicate that this is not due to the existence of particles of smaller mass, but comparison with the behaviour of negatively charged particles seems to show that this difference is due to a difference in the velocities of the particles. A note is added on a method of measuring the effective magnetic field in the magnetic deflection of the canal rays.

A. E. G.

129. *Photo-electric Effect on Mercury in Polarised Ultra-violet Light.* R. Pohl. (Deutsch. Phys. Gesell., Verh. 11. 21. pp. 609-616, Nov. 15, 1909.)—The behaviour of mirrors of Pt and Cu has been considered in a previous paper [Abstract No. 1734 (1909)]. It is now found that a fluid mercury surface shows in polarised ultra-violet light a behaviour similar to that of solid metals sensitive to that light, that is, the dependence of the photo-electric current on the azimuth of the electric vectors for different angles of incidence, is explained by a simple proportionality between the number of the emitted electrons and the quantity of light absorbed. A full description, with a diagram of the experimental arrangements, is given.

A. E. G.

130. *Photo-electric Sensibility of Potassium as a Function of the Wave-length.* W. Hallwachs. (Ann. d. Physik, 80. 3. pp. 598-597, Nov. 4, 1909.)—Up to

the present it has been thought that the alkali metals possess a maximum of photo-electric sensibility in the region of the visible rays. This property has now been investigated for potassium, using a quartz mercury-arc lamp, and it is found that the specific photoelectric sensibility steadily increases from 0.027 at $\lambda = 578$ to 7.1 at $\lambda = 217$, so that potassium has no maximum in the visible region, and therefore does not differ from other metals.

E. C. C. B.

181. *Ion-mobility of Radio-active Atomic Residues and Mass of Gaseous Ions.* J. Franck. (Deutsch. Phys. Gesell., Verh. 11. 19. pp. 397-405, Oct. 15, 1909. Physikal. Inst. d. Univ., Berlin, Sept., 1909.)—Discusses the opposed views (1) that the ion consists of one molecule or atom bearing an element of charge, or (2) that it consists of such a molecule or atom with a group of attendant uncharged molecules; and finds the arguments inconclusive. The positively-charged radio-active atomic residues of ThD have extremely small mobilities in air, nitrogen, and hydrogen, which are substantially equal to those of positive ions in the surrounding gas; whence it would follow that the ion-mobility is independent of the mass of the dissociated molecule. Though Wellisch and Sutherland both come to regard the ion as being a single charged atom, the former could not, while the latter may, come to the observed value of the mobility of the ThD atomic residue. A. D.

182. *Ionisation in Various Gases.* E. P. Metcalfe. (Phil. Mag. 18. pp. 878-889, Dec., 1909.)—A research undertaken to gain further evidence on the view that the ionisation per molecule is the sum of the ionisations contributed by the atoms composing the molecules, the contribution of each atom being characteristic of that atom and not influenced by the manner of the chemical linkage or by the presence of the other atoms in the molecule. Values were obtained for the ionisation per molecule for members of sequences of compounds of the same two elements, as O_2 , CO_2 , CO , N_2 , N_2O , NO , and the first four members of the series of paraffin gases. An insulated electrode inside an ionisation chamber, and the walls of the chamber itself, were coated uniformly with uranium nitrate, and the time of fall of potential by leakage through a known p.d. was measured for each pressure-reading of the gas contained in the chamber. The additive rule stated above was found to hold, the correspondence between ionisation and chemical composition being very close in the case of the paraffin gases, e.g., taking air as 1, the relative molecular ionisations in these gases are represented by the numbers: hydrogen, 0.283; methane, 1.10; ethane, 2.08; propane, 3.05; butane, 4.02; pentane (Laby's value), 4.88. The value found for helium was 0.211.

G. E. A.

183. *Electric Discharge through the Halogen Acids.* L. Vegard. (Phil. Mag. 18. pp. 465-483, Oct., 1909.)—The general character of the discharge is the same as for elementary gases. In HCl and HBr the discharge could be kept constant and with a uniform structure within wide current-intervals; the conditions were "reversible"; for HI a constant discharge could only be obtained for very small currents. Within the interval of reversibility the decomposition is too small to affect the discharge. The characteristic curve depends on the history of the tube, and a change in structure of the discharge is always accompanied by a fall in the potential gradient in the positive column. Under comparable conditions the potential gradients in HCl , HBr , HI follow the order of the molecular weights. The variations of potential

gradient with current for HCl and HBr follow Hertz's law except for very small currents. The normal kathode-fall is found for HCl and HBr; the smallest pressure that can give a normal kathode-fall is the same for oxygen, HCl and HBr. The anode-fall in the interval of observation is found to be expressible by either of the two functions—

$$A = A_0 + a_1 p + p(a_2 - bp)e^{-p}, \text{ or } A = A_0 + \{B^{-1} + [p(a_1 + a_2 e^{-p})]^{-1}\}^{-1};$$

so that by diminution of pressure the anode-fall approaches a minimum value (A_0) independent of current I ; and for somewhat large currents (λ not being too small) the anode-fall will be nearly independent of current and follow a linear law with regard to pressure. The electric absorption of gas by the walls of the tube is found to be closely connected with the size of the kathode-fall, which leads to the assumption that the absorption is chiefly caused by positive ions being shot into the kathode. A. D.

134. *Kathode Volatilisation*. VI. V. Kohlschütter. (Zeitschr. Elektrochem. 15. pp. 980-987, Dec. 1, 1909.)—A continuation of the controversy with F. Fischer and J. Stark [compare Abstracts Nos. 178, 581, 1278, 1582, and 1684 (1909)]. New experiments with Pt and Au and other metals in oxygen, made at constant pressure, current intensity and kathode-fall, confirm the author in his opinion, that the volatilisation depends both upon the metal and the gas. He admits at the same time that the phenomena cannot be ascribed to ordinary chemical reactions, and is inclined to accept the importance of Stark's atom rays. H. B.

135. *Striae formed in Dust Tube by Electric Sparks*. T. J. Richmond. (Phil. Mag. 18. pp. 771-782, Nov., 1909.)—In 1898 H. V. Gill propounded a theory of the striation of the electric discharge in vacuum tubes, in which he drew attention to the fact that under suitable conditions, lycopodium powder placed in a glass tube arranges itself in well-marked striæ under the influence of an electric discharge. This suggested the experiments here described on the various factors involved in the formation of these dust striæ, the special object being to ascertain whether the frequency of the electrical oscillations could be obtained from observation of the striation of the powder under their influence. Oscillatory spark discharges of various frequencies were used and measured by Fleming's cymometer, and the striations measured by a traversing microscope, but they were found to be not proportional to the electrical wave-lengths. It was thought that the nature of the striation might conceivably depend upon the powder used (on its density and the size and shape of the grains), also on the diam. of the tube containing them and at the end of which the electric spark occurred. As to the influence of the tubes, a certain diam. was found to give a max. striæ distance, thus in one set of experiments a diam. of 1.6 cm. gave a striæ distance of 1 mm., larger or smaller tubes giving finer striæ. The testing of various powders supports the view that the striæ distances depend also upon the nature and size of the grains composing it. Thus lycopodium and pepper, each consisting of spheroidal grains, gave distances of 0.84 and 0.81 mm. respectively, egg-powder and boric acid (each of small round particles) gave striæ distances of 0.78 and 0.70 mm., while powdered charcoal (long narrow needles) gave 1.2 mm. as the striæ distance. Zinc chromate seemed too light to form the striæ at all, each spark causing the particles to jump, after which they fell

haphazard and formed no regular figure. The various effects obtained in different cases are shown in photographs occupying six plates. [See also Abstract No. 1047 (1898).] E. H. B.

136. Hertz's Discharge Phenomenon and the Aureole around a Discharge of the Spark, Glow, or Arc Type. W. Matthies. (Ann. d. Physik, 80. 4. pp. 688-696, Nov. 30, 1909.)—The investigation takes its rise in a phenomenon observed and investigated by Hertz (Wied. Ann. 19. p. 78, 1888). This is shown to be a special case of a phenomenon which may accompany discharge in general—spark, glow, arc. At a suitable pressure there may be observed around the path of the discharge proper a luminescent envelope separated by a dark space from the bright discharge space. This bright envelope is called the "aureole." Pressures in the experiments vary from 4 mm. to 88 mm. The aureole is an effect secondary to the discharge itself, and is due to the strongly ionised gas, which is hurled out of the discharge path. The recombination of the electrons and positive ions is accompanied by a release of energy, which shows itself in part in luminescence. The dark space between the discharge path and the aureole is the space in which the ions move free through the gas without any appreciable recombination. There is no potential-fall radially in the aureole itself. By proper arrangement the aureole may be obtained in the form of a beam, which possesses all the properties of an ordinary gas current. This beam cannot be deflected electrically or magnetically. A disruptive discharge is much more favourable to the formation of the aureole than a continuous one. T. P. B.

137. Oscillatory Discharge. A. Battelli and L. Magri. (Accad. Lincei, Mem. 7. No. 9. pp. 597-617, 1909.)—The paper is in three sections, the first being a review of the work on the spark discharge in air, including the author's previous work [see Abstracts Nos. 1211, 1671 (1907)], the second referring to the air discharge, and the third to the metallic vapours in the spark. Numerous reproductions of photographs of the spark, with and without rotating mirror, are given, which illustrate the effect of increasing inductance upon the spark. The restriction to a fine line produced with greater inductance, and the travelling of luminous clouds of metallic vapour given off from the electrodes along the path of the spark, may be very clearly followed. Amongst numerous results and conclusions, the following may be noted: With small inductance the first discharge is explosive, but the ionisation falls so rapidly that the second and following discharges are also of a similar character, while with larger inductance the first discharge is explosive, but the decay of ionisation is less rapid and the second and following oscillations are of the nature of an arc discharge. Spectroscopic analysis shows that in the former case all the oscillations give line spectra, but in the latter, the first gives a line spectrum and the following oscillations band spectra. In the case of metallic vapours two kinds of tufts or clouds are noticed, viz., the long and the short. The long tufts are produced when the inductance is small, and the short ones when the inductance is greater. These clouds of vapour appear to be given off at the explosive stage of the discharge and to travel from the electrode with continually diminishing velocity. Their luminosity varies from instant to instant and depends upon the activity, electrical or chemical, at each point of their path. S. G. S.

138. Heating of a Conductor by an Oscillatory Discharge. A. Léauté. (Comptes Rendus, 149. pp. 1064-1066, Dec. 6, 1909.)—The author assumes

that the air surrounding the wire is at a constant temperature and that the heat is radiated according to Newton's law. The complete solution of the differential equation is obtained and the effects produced by varying the frequency, amplitude, and damping are studied. It is proved that when a fine wire is traversed by a condenser discharge, the increase that is noted in the violence of the explosion when the inductance of the circuit is diminished is due to the simultaneous increase of the amplitude and the damping of the current in the circuit. The increase of the frequency tends to diminish the violence of the explosion. A. R.

139. *Reflection and Anomalous Dispersion of very Short Electric Waves by Liquids.* H. Merczyng. (Comptes Rendus, 149, pp. 981-983, Nov. 29, 1909.)—A preliminary note giving the results of the author's work on the determination by short electric waves of the dielectric constants of some liquids which do not obey Maxwell's law. He uses an oscillator of the Righi type and measures the length of wave by interference from two mirrors slightly inclined to each other. The wave-length λ was 4.5 cm. A thermo-element was used as detector. The method is that of determining the ratio of the intensities of reflected and direct waves. From this and the angle of incidence the index of refraction μ is determined by Fresnel's formula. The dielectric constant K is then set $=\mu^2$. The results are as follows:—

Liquid.	K from Optical μ .	K for $\lambda = 4.5$ cm.	K for long Electric Waves.
Glycerine	2.1	16.8	56
Alcohol (methyl).....	1.8	29.4	32.5
Alcohol (amyl).....	1.9	3.81	16
Acetic acid	1.9	8.5	9.7
Aniline	2.5	4.86	7.4
Ether (ethyl)	1.9	3.26	4.25

T. P. B.

140. *Stationary Electric Waves on Straight Wires whose Capacity and Self-induction change suddenly at particular Points.* J. Wallot. (Ann. d. Physik, 30. 3. pp. 495-578, Nov. 4, 1909. Habilitationsschrift, Stuttgart.)—A long paper, in part theoretical, in part experimental, on stationary waves in a circuit of the ordinary form, viz., small capacity, with long narrow rectangle of wire. The rectangle, however, is divided into three sections of wire of different thicknesses or, it may be, the wires pass through different dielectrics. Special attention is paid to the conditions which determine the position of a "null-point," i.e., a point at which a disturbance such as a change of capacity and self-induction may be introduced without affecting the period of oscillation of the system. The experimental arrangements are very similar to those which Drude perfected for measurements with stationary waves of short length. In this case, however, resonance is always obtained by adjustment of the primary capacity. The paper may be summarised as follows: A transcendental equation is established, by which the period of oscillation of the circuit mentioned above may be calculated. From this equation it may be deduced that (1) if sections 1 and 3 of the rectangle are the same, the position of the disturbing section 2 has no influence on the period of oscilla-

tion only then when the self-induction and capacity of section 2 change in the same proportion; (2) a "null-point" is only possible if, as for instance in the case of thicker and thinner wires, the capacity of the disturbing part per unit of length increases while its self-induction decreases, or *vice versa*; in addition the ratio of condenser capacity to wire capacity may not pass beyond a certain limit. (8) In the case of thicker and thinner wires in a disturbing section of no great length, the position of the "null-point" is given by the equation $q_0 = (\tan^{-1} \sqrt{m})/Z_0$, where—

$$m \log_{10} d/\rho = \log_{10} [0.5 + \sqrt{0.25 - (\rho_2/d)^2}] - \log_{10} \rho_2/d.$$

And Z_0 is a root of the equation $Z_0 \tan Z_0 = L/4C \log_e d/\rho$. L = length of parallel wires, C = capacity of condenser, $q_0 = l/L$, where l = distance of "null-point" from the bridge, ρ_2 = radius of disturbing wire, ρ = radius of rest of wire, d = distance of wires from each other. (4) If the self-induction of the disturbing part per unit of length is μ times as great as that of the rest of the wire, while its capacity is ϵ times as large, a disturbing part of small length acts at a potential-node like a piece of the rest of the wire of μ times the length, while at a potential-loop it acts like a piece of ϵ times the length. The experiments confirm the theory in so far as a thickening of the wires at a potential-node lowers the period of oscillation, while at a potential-loop it increases it. So that between node and loop a "null-point" may be found by experiment, provided L is fairly large in comparison with $4C \log_e d/\rho$. Near a potential node experiment also confirms theory, but at a greater distance the influence of a thickening of the wires is greater than theory gives. An empirical formula brings experiment and theory into unison. Theory is also confirmed by experiments where the wire passes through a short piece of wood. Under favourable circumstances the author can fix the position of a potential-loop so accurately that the readings do not differ from each other by more than 1/1000 of the wave-length measured.

T. P. B.

141. *Bjerknes Formula and its Application to Determination of Damping in Oscillatory Circuits.* J. Bethenod. (*Lumière Électr.* 8, pp. 801-808, Dec. 4, 1909.)—Writing Bjerknes' equation, which gives the sum of the logarithmic decrements in a primary and a secondary circuit, in the form $J^2/J_0^2 = (a_1 + a_2)/(a_1 + a_2)^2 + (\omega_1 - \omega_2)^2$, where J = effective amplitude in the secondary, when its frequency = n_2 ; J_0 = the same, when its frequency = n_1 , the frequency of the primary; $a_1 = n_1 \log_{10} \text{dec.}_1$; $\omega_1 = 2\pi n_1$; $a_2 = n_1 \log_{10} \text{dec.}_2$; $\omega_2 = 2\pi n_2$, the author modifies it as follows:—

$$\text{Let } \tan \theta = (\omega_1 - \omega_2)/(a_1 + a_2),$$

$$\text{then } J^2/J_0^2 = 1/(1 + \tan^2 \theta),$$

$$\therefore J = J_0 \cos \theta.$$

Thus from $J/J_0 \cos \theta$ is determined and so $a_1 + a_2$ is determined, if we know $\omega_1 - \omega_2$. In the remainder of the paper the author modifies very slightly the usual method for separating a_1 and a_2 , i.e., the method of inserting an auxiliary resistance in the secondary.

T. P. B.

142. *Symmetrical and Unsymmetrical Electromagnetic Waves along Wires.* D. Hondros. (*Phys. Zeitschr.* 10, pp. 804-806; Discussion, p. 806, Nov. 10, 1909. Paper read before the Versamml. Deutsch. Naturforscher u. Ärzte,

Salzburg, Sept. 21, 1909. *Ann. d. Physik*, 30. 5. pp. 905-960, Dec. 14, 1909. Extract of Dissertation, München.)—Theory and experiment give the existence of one symmetrical wave in the transmission of an electromagnetic disturbance along a wire. The questions discussed in this paper are: (1) Is this the only possible symmetrical wave? (2) what is the form of the unsymmetrical waves, which are certainly present? (3) why is the one well-known wave alone produced even when the disturbance is excited in an unsymmetrical manner? The mathematical theory is not given, but its results are. There are three types of waves present: (1) A wave-type in which the magnetic lines are circles round the wire; (2) a type in which the electric lines are circles round the wire; (3) a host of unsymmetrical waves. In the first class is the one well-known wave of small damping, but in addition to it there is a whole series of secondary waves very strongly damped. The other two classes consist of very strongly damped secondary waves. In a copper wire 4 mm. in diam., for a frequency of 10^9 per sec., the velocity of the first of any of these series of strongly damped secondary waves comes out to be 12.5 km. per sec., and its amplitude falls to $1/e$ of its original value in 0.002 mm. T. P. B.

143. *Crystal and Solid Contact Rectifiers.* A. E. Flowers. (*Phys. Rev.* 29. pp. 445-460, Nov., 1909.)—An account of an investigation of the mode of action of such rectifiers, commencing with a search for a rectifier of larger current-carrying capacity for low-frequency currents. The copper-galena rectifier is first examined and the volt-amp. characteristic given; the effect of the shape of the point and size of contact area is also examined. The highest current-carrying capacity was found to be obtainable by using galena in combination with a copper point which had been subjected to electrochemical treatment with amorphous sulphur. For this purpose the copper point is covered with burning sulphur, the flame blown out and the remaining sulphur cooled quickly. Such a point at first shows little conductivity, but after passage of the current, first in one direction and then in the other, rectification is produced though in the opposite direction to that found in native crystals. Treatment of a crystal previously possessing no rectifying properties resulted in rectifying properties being obtained similar to those with the treated copper point. As an example of the values observed the following may be given:—

P.D. Lead to Copper, volts.	Current, amps.	Resistance, ohms.		Ratio of Resistances.
		Cu to Pb.	Pb to Cu.	
-1.0	0.002	500	—	—
+0.6	0.404	—	1.485	0.00297

The following are some of the conclusions arrived at: The rectifying action is produced at the surface or in a surface film, and is not due to the point employed; it is not an effect of the sharpness of the point or the ratio of contact areas. The rectifying film will break down at a moderate voltage (6 to 15 volts), which is higher the smaller the current. The feeble evanescent e.m.f. existing after the passage of current in either direction, has a direction opposite to that which would be required for rectification. The rectification disappears at high temperature, *i.e.*, about 270° C., but is partially regained on cooling; it is probably due to the electrochemical formation of a resisting film at each reversal. The film can be produced artificially by electrochemical treatment with amorphous sulphur. L. H. W.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

144. Contact Electrification. A. Grumbach. (*Comptes Rendus*, 149. pp. 846-848, Nov. 15, 1909.)—By means of the e.m.f. of filtration, the author has carried out experiments with a view to ascertaining if the electrification at the contact-surface of an electrolyte and an insulator such as glass is influenced by solution of an insulator in the conducting liquid. When a liquid conductor is filtered under pressure through a capillary tube or through a porous wall, it produces an e.m.f. which, when the tubes are sufficiently long and narrow for the flow to follow Poiseuille's law, obeys the laws of Helmholtz: $E = \frac{3}{2} \rho P / \eta$, where ρ is the resistivity, η the viscosity of the liquid, E the p.d. between one part of the diaphragm and the other, P the difference of pressure and $\frac{3}{2}$ the moment of the double layer formed at the surface of separation of liquid and tube. The ratio E/P for a solution of potassium chloride containing 0.001 gm.-mol per litre at 17° is found to be 56.6-58.9, whilst if 56 gm. of phenol per litre are also present the ratio has the value 39.4-41.2. The viscosity of the second solution is greater than that of the first in the proportion 1.09:1. The ratio of the values of $\frac{3}{2}$ for the solutions with and without phenol is found to be 0.80, a second series of measurements giving the number 0.78. Hence, a soluble non-conducting substance may modify the contact electrification at the surface of separation of an electrolyte from a non-conducting wall. T. H. P.

145. Quantitative Validity of the Law of Charge for Dielectrics. A. Coehn and U. Raydt. (*Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse*, 8. pp. 263-288, 1909. *Ann. d. Physik*, 80. 4. pp. 777-804, Nov. 30, 1909.)—Coehn had already established the law that substances of higher dielectric constant become positively charged in contact with substances of lower dielectric constant. The above authors now show that the law is quantitative as well and that the charge depends on the value of the dielectric constant. The law has been obtained by measuring, in an ingenious apparatus, the ascension of the liquid in a capillary tube under a given electric potential. Twenty-four different pure substances were investigated, and with only a few exceptions (especially noticed in the case of nitro-compounds) it was found that the electric charge was proportional to the difference of dielectric constants of the substances in contact. The reason for the abnormal behaviour of the nitro-compounds has not yet been obtained. In the case of mixtures the electro-capillary ascensions showed the same regularities as do the dielectric constants. Further, the temperature-coefficients of the electro-capillary ascensions agree with those obtained by other investigators for the temperature-coefficients of dielectric constants. A. F.

146. Resistivity and other Electric Properties of Steel. H. Pêcheux. (*Comptes Rendus*, 149. pp. 1062-1064, Dec. 6, 1909.)—Four brands of commercial steel have been studied, two soft and two hard, so as to determine the influence of the carbon and Si upon the resistivity and the thermoelectric properties. The results obtained are summed up in the following formulæ, where the resistivities are given in microhms:—

- H. Very soft steel, $\rho_t = 11.75 (1 + 0.085t + 0.048t^2)$.
 A. " " " $\rho_t = 18.50 (1 + 0.087t + 0.074t^2)$.
 B. Semi-hard steel, $\rho_t = 11.25 (1 + 0.040t + 0.089t^2)$.
 I. Hard steel, $\rho_t = 15.42 (1 + 0.040t + 0.054t^2)$.

Copper-steel couples were then made. $\partial E/\partial t$ represents the thermoelectric power of each couple, T_n the neutral point, T_i the point of inversion, and T_b the point before the point T_i where the curve bends appreciably. The following table gives a summary of the experimental results:—

	Carbon, per Cent.	Silicon, per Cent.	$\partial E/\partial t$ (microvolts), per deg.	T_n	T_i	T_b
A. Soft steel.....	8	Traces	$-18.20 + 0.0576t$	280°	515°	400°
H. Hard steel	4	0.1	$-11.58 + 0.0468t$	245	525	420
B. Semi-hard steel	6	Traces	$-12.10 + 0.0562t$	215	465	380
I. Hard steel	8	0.1	$-9.08 + 0.0428t$	211	435	400

The tables show that the greater the percentage of carbon the lower, as a rule, is the temperature T_n of the neutral point. The presence of Si tends to raise T_n in soft steels, but in hard steels the influence of the carbon is the greater. The temperature of the point of inversion is always more than double the temperature of the neutral point. In steels the neutral point has a lower temperature than in pure iron. A. R.

147. *Apparatus for Radio-active Measurements.* B. Szilard. (Comptes Rendus, 149. pp. 912-914, Nov. 22, 1909.)—The instrument is in principle the same as the electroscope, but the gold leaf is replaced by a rigid index. This index is a magnetised steel needle suspended on a vertical axis, and the earth's magnetic force plays in this case the same rôle as gravitation does in the gold-leaf electroscope. The needle when in the position of rest is encased by a metallic ribbon with which it is in electrical contact. When the system receives a charge the needle leaves its position of rest and the magnetic force tends to bring it back to its original position. The sensibility therefore depends on the magnetisation of the needle and on the intensity of the earth's magnetic field. To diminish the action of the latter, and also to avoid any effects due to the presence of large masses of iron, the box containing the system is furnished with a soft-iron base and a soft-iron ring is placed on its top. The measuring system is fixed upon an insulating support and is placed symmetrically in the cylindrical metal case. A scale and suitably placed reading lens are provided. Diagrams and detailed descriptions are given. A. E. G.

148. *Thermo-hysteric Frequency Meter.* C. E. Hiatt. (Phys. Rev. 29. pp. 432-444, Nov., 1909.)—The author makes use of the action of an alternating current in setting up an alternating field in a small mass of iron or steel soldered to one junction of a pair of opposed copper-constantan thermocouples. The couples are adjusted so as to give normally zero deflection on a sensitive galvanometer, and the deflection produced by the heat due to hysteresis of the alternating field is found, for a given value of the current, to follow a straight line law approximately for currents which are sufficiently small. Curves are given showing the deflections obtained for currents of constant value (regulated throughout) of 0.15, 0.10, and 0.05 amp., the iron used being 0.8 cm. $\times$ 0.02 cm. $\times$ 0.08 cm., and the frequencies tried 400 to 1400 $\sim$ per sec. The applications of the method are discussed. A comparator for the comparison of alternating current with direct current is also described in which the principle of opposed thermo-junctions in combina-

tion with small manganin "heaters" is employed. The arrangement is considered to offer an accurate and inexpensive means for the measurement of very large currents with manganin shunts only one-tenth the usual size.

L. H. W.

ALTERNATING CURRENTS AND MAGNETISM.

149. *Production of Continuous Current by a Pure Alternating E.M.F.* J. v. Geittler. (Phys. Zeitschr. 10. pp. 795-808; Discussion, pp. 808-804, Nov. 10, 1909. Paper read before the Versamml. Deutsch. Naturforscher u. Ärzte, Salzburg, Sept. 21, 1909. Deutsch. Phys. Gesell., Verh. 11. 20. pp. 448-462, Oct. 80, 1909. Akad. Wiss. Wien, Sitz. Ber. 118. 2a. pp. 708-726, May, 1909.)—A general theory is developed of the production of continuous current by a pure alternating e.m.f. impressed on a circuit whose resistance varies in a periodic manner. The theory covers all cases of so called "electric valves." The solution of the equation $L \cdot di/dt + Ri = E$ gives, when R varies periodically, a direct-current component to the current. This is substantiated by experiments both with an alternating e.m.f. of ordinary low frequency and with an alternating e.m.f. of the high frequency of a Hertz oscillator. An arc burning under an ordinary alternating e.m.f. gives a direct-current component in a circuit in parallel with it. Likewise in a Lecher wire system a spark-gap across the wires gives a direct-current component in the part of the wire system in parallel with the spark-gap. The variable resistance is in the arc and the spark. This current is not always in the same direction. A change in the arc causes its direction to change suddenly. In the wire system there is a close connection between the length of the spark and the direction of the current, the direction alternating in a consistent manner as the length is reduced, e.g., in some cases three times, as the length is reduced from 5 mm. to zero. A method of transmission of direct current by wireless telegraphy is indicated. The use of vacuum tubes as indicators in experiments with waves on wires may, in many cases, prove to be a source of error.

T. P. B.

150. *Agreement of Magnetic and Electrical Properties of Materials with Mechanical Tests.* A. Günhut and J. Wahn. (Zeitschr. Elektrochem. 15. pp. 894-895, Nov. 15, 1909. Paper read before the 5th Internat. Congress for Testing Materials, Copenhagen, 1909.)—The authors give a *résumé* of the work establishing the relationship between magnetic and mechanical properties. Every kind of mechanical stress, tension, compression, alternating, torsion, &c., finds expression in certain alterations in the temporary and permanent magnetism, and on the other hand, the effect of magnetism on the elastic constants of magnetic metals, and on the volume and length of test pieces has been shown. In general it has been shown that the temporary magnetism induced by a definite magnetic force, at first rises rapidly with the temperature, then more slowly until a maximum is attained, after which the magnetism falls rapidly. To each magnetic force there corresponds a critical temperature at which the magnetism attains its max. value, and at each temperature there is a critical value of the magnetic force. Since permanent magnetism decreases rapidly with the temperature, and disappears entirely at high temperatures, demagnetising is best effected by heating to redness. Variations in the structure of a pure metal lead to variations in resistance, and Benedicks has shown that equivalent quantities of dissolved

impurities in iron produce the same increase in resistance. The resistance at different temperatures depends not only on the temperature itself, but on whether the temperature has been approached from above or below. This phenomenon is connected with the structural changes produced in the metal, as is evident from the fact that the increase of resistance on hardening steel is further increased on tempering. The relations between electrical conductivity and magnetic properties are exactly parallel, so that the determination of the electrical conductivity can serve to establish the magnetic homogeneity of a metal. F. C. A. H. L.

151. *Measurement of High Magnetic Inductions.* E. Gumlich. (Elektrotechn. Zeitschr. 80, pp. 1085-1087, Nov. 11, and pp. 1098-1100, Nov. 18, 1909. Communication from the Physikal.-Techn. Reichsanstalt.)—A modification of Ewing's isthmus method is described, whereby different iron specimens may be tested in fields from 180 to upwards of 6500 c.g.s. units, with little or no change in the apparatus. The specimens, instead of being in the form of a double cone with a narrow connecting neck, are cylindrical, about 28×8 mm., and inserted for about 4 mm. at each end into cones of soft iron. A description is given of the winding of the coils over the specimens, and of the manner of accurately calculating the values of H and B. The method enables tests to be made at such low fields as to considerably overlap the range of application of the yoke method. Tables are given of the results of combined yoke and isthmus tests on various varieties of iron in fields from 0.25 to 6500 gauss. A. D. R.

152. *Magnetic Induction in Iron with an Alternating Field.* H. Hausrath. (Phys. Zeitschr. 10, pp. 756-782, Nov. 1, 1909.)—The paper gives an account of a method of examining the magnetic induction of iron in a rapidly alternating field, and of obtaining the corresponding hysteresis curves by an oscillographic method. The results are given of some tests on bars built up from strips of transformer sheet iron. A. D. R.

153. *Effect of Temperature on Hysteresis in a Rotating Field.* W. P. Fuller and H. Grace. (Phil. Mag. 18, pp. 866-871, Dec., 1909. Paper read before the Physical Soc., May 14, 1909.)—The rotating field was imitated by passing two phase-currents through stationary coils at right angles to one another. The flux in the iron specimen was measured by means of a coil of mica-insulated bare wire, wound on the specimen and connected to a specially constructed galvanometer containing four conical coils connected in pairs to the two phase-currents, a movable coil at the centre being placed in series with the search coil wound on the specimen. The theory and mode of use of the galvanometer are given, and curves expressing the results are drawn; these show that the effect of increasing the temperature of iron is to greatly reduce the hysteresis loss at a given induction, and to cause the max. hysteresis to occur at a lower value of B (induction). G. E. A.

154. *Magnetic Alloys of Non-magnetic Elements.* E. Wedekind. (Zeitschr. Phys. Chem. 66, 5, pp. 614-632, June 1, 1909.)—After summarising the chief experimental results hitherto published, the author gives an account of magnetometric and ballistic tests on compounds of Mn with B, Sn, P, and Sb, and compares them with the results for Fe, Co, &c. Owing to the difficulty of preparing the alloys, the test material was generally in the form of

powder or in bars about 8 cm. long. The coercive force of certain of these Mn compounds exceeds that of most varieties of iron or steel. Manganese boride possesses so much permanent magnetism as to render it suitable for compass needles. With many of the alloys the stronger their permanent magnetism the feebler was their temporary magnetism. A. D. R.

155. *Magnetic Properties of Magnetite Crystals.* V. Quittner. (Ann. d. Physik, 80, 2, pp. 289-325, Oct. 14, 1909. Extract from Dissertation, Zürich.)—An extension of the work of P. Weiss, who has shown that magnetite and pyrrhotine do not behave magnetically as isotropic substances [see Abstracts Nos. 1780, 2269 (1906)]. Ballistic and deflection methods were employed in determining the properties of circularly cut crystalline plates of magnetite from 12 to 20 mm. in diam., and varying in thickness from 0.1 to 0.8 mm. In general the direction of magnetisation in the crystal does not coincide with that of the applied field, and curves are given of the parallel and normal components of magnetisation for varying direction of the plate. It is assumed that with such thin plates the demagnetising effect destroys the magnetisation perpendicular to the plate. Curves are also given of the rotation hysteresis of the plates, and the crystallographic axes may be distinguished by means of their different permeabilities. A hypothesis as to the internal structure of the magnetite crystal is sketched. G. E. A.

156. *Dip-needle Corrections.* P. H. Dike. (Terrestrial Magnetism, 14, pp. 187-146, Sept., 1909.)—For a limited range of dip it is generally found that for a good dip circle with well-made needles the corrections are sufficiently close for magnetic surveys so long as the observations are not more than 5° to 10° different from the value at the base comparison station. In the case of the Carnegie Institution's experimental yacht *Galilee*, however, the range of dip was from $+74^{\circ}$ to -68° , and under these conditions the corrections obtained from a one-base station cannot be assumed to be applicable. For the reduction comparisons were made between all the ship instruments while in port, and with observatory standards at Cheltenham, Washington, Sitka, Honolulu, Apia, Tokio, Zi-ka-Wei, and Christchurch, New Zealand. An experimental apparatus was set up consisting of two pairs of Helmholtz constant field coils, at the centre of which was placed the ship's dip circle to be tested. In order to eliminate as far as possible unknown effects of the magnetic variations during the work two complete installations were employed in different buildings, but with the two horizontal force coils connected up in the same electrical circuit, and similarly the two vertical force coils; this made it possible to have one factor, the magnetising current, constant for both installations. The artificial magnetic dip was then measured at the centre of the coils with a Schulze earth inductor, and immediately afterwards with the dip circle to be tested. For the actual comparisons two observers are required, one for reading the needle while the other keeps the magnetising current steady by means of suitable resistances. Simultaneous observations are made with the earth-inductor and dip circle, three complete sets with four needles, occupying about an hour for each set. Stations are then interchanged with the two instruments to eliminate station differences.

C. P. B.

157. *Magnetic Storm and Aurora, Sept. 25, 1909.* A. Angot. (Comptes Rendus, 149, pp. 577-578, Oct. 4, 1909.)—This storm was the most intense

that had been registered at the Parc-Saint-Maur station since its inauguration in 1888. The perturbations began abruptly at 11h. 50m. (Paris mean time), and lasted until 21h. 20m. The declination, of mean value $14^{\circ} 30'$, fell to 12° about 12h. 40m., and then rose to 16° at 16h. 56m. The horizontal force, of mean value 0.1974, passed from 0.2040 at 16h. 37m. to 0.1942 about 20h. The total variation in declination was therefore about 8° , and in horizontal force about 0.0098, being thus greater than the storm of Oct. 31, 1908, where the declination oscillation was $2^{\circ} 4'$, and the horizontal force 0.0068. Very vivid auroral displays were observed all over France. At Conquet Rogache describes it as consisting of an extensive arch, with its summit towards NNE., and with rays shooting upwards, almost to the zenith, having a purple or violet colour. The summit of the arch was very near the magnetic meridian. W. Sidgreaves. (*Nature*, 81, p. 426, Oct. 7, 1909.)—From the beginning of Sept. the magnets had been comparatively quiet. At 8.30 a.m. on the 25th the coming storm was foreshadowed by a sudden small disturbance indicating an eastward movement in declination and a diminution of the components of force. The general deflection during the storm proper was westward. The general characters of the various types of oscillation throughout the storm bear a great resemblance to those shown by earthquake phenomena. (*Electrician*, 68, pp. 1041-1043, Oct. 8, 1909.)—The great magnetic disturbance on Sept. 25, 1909, caused world-wide disturbance of the telegraph and telephone lines. Traces of the records obtained at Kew showing the actual changes in declination, horizontal force, and vertical force indicate that about 11.48 a.m. the magnetic storm was commencing, the intensity increasing so rapidly that after about 12 min. the spot of light was driven off the paper, showing a movement of more than $72'$ to the east. Soon after 12.52 the spot drifted back across the sheet, disappearing then at the opposite side about 1.20 p.m. The motion across the sheet represents $2^{\circ} 7'$, and the real movement must, of course, have been more than this. Between 8.7 and 8.22 p.m. a movement of $98'$ to the west was followed by one of $84'$ to the east. This is the largest storm since that of Oct. 31, 1908, and its chief characteristic is its highly oscillatory character. C. P. B. 158. *First Magnetic Observations of the Survey Yacht "Carnegie."* L. A. Bauer and W. J. Peters. (*Nature*, 81, pp. 539-538, Oct. 28, 1909.)—A brief description is given of the magnetic apparatus, the methods of observation, and the results obtained in Gardiner's Bay, Long Island, and along the steamship track from New York to England. The chief difficulties experienced were due to the state of the sea, and to meteorological conditions preventing observations of celestial bodies for declination measurements. Declinations are obtained as a rule to within 0.1° , and rarely is the error as much as 0.2° . The average error in determinations of H is less than 0.001. Employment of the marine collimating compass has reduced to one-third the time necessary to determine declination. The observations show that along the track of transatlantic liners the British, U.S., and German charts are usually accurate to within 1° in the variation. The errors are, however, of a systematic nature, which is apt to turn off vessels northwards towards Sable Island to a dangerous extent. A. D. R.

REFERENCES.

150. *Maxwell Forces in Elastic Media.* C. Somigliana. (*Accad. Lincei, Mem.* 7. No. 8, pp. 577-595, 1909.)—A mathematical treatment. [See Abstract No. 1913 (1909); also No. 482 (1908).]

160. Electrons and Relativity Principle. **M. Born.** (Phys. Zeitschr. 10, pp. 814-817; Discussion, p. 817, Nov. 10, 1909. Paper read before the Versamml. Deutsch. Naturforscher u. Ärzte, Salzburg, Sept. 21, 1909.)—A treatment of the dynamics of the electron in the kinematics of the relativity principle and concerned chiefly with the hyperbolic motion represented by the two invariant hyperbolæ $x^2 - c^2 t^2 = \pm 1$, c being the speed of light. [See also Abstracts Nos. 1990, 1993 (1908), and 1723 (1909).]

E. H. B.

161. Electromagnetic Phenomena in Moving Bodies. **A. Szarvassi.** (Phys. Zeitschr. 10, pp. 811-813; Discussion, p. 813, Nov. 10, 1909. Paper read before the Versamml. Deutsch. Naturforscher u. Ärzte, Salzburg, Sept. 21, 1909.)—A mathematical discussion of electromagnetic phenomena in moving bodies, based on Maxwell's equations and the conservation of energy.

E. H. B.

162. International Conference on Electrical Units and Standards, 1908. Appendix to Report. (Electrician, 64, p. 280, Nov. 26, 1909.)—The Appendix contains particulars of the various methods pursued by the standardising laboratories in America, France, Germany, and Great Britain to realise the International ohm, the International ampère, and to prepare the Weston normal cell.

F. E. S.

163. Crystals Rectifiers. III. Iron Pyrites. **G. W. Pierce.** (Phys. Rev. 29, pp. 478-484, Nov., 1909.)—An extension of previous work [Abstract No. 1295 (1909)] to the case of rectifiers using iron pyrites, one of the substances originally investigated, and found to conduct asymmetrically, by F. Braun.

L. H. W.

164. General Theory of Electrostatic Measuring Instruments. **J. del Pulgar and T. Wulf.** (Ann. d. Physik, 80, 4, pp. 697-718, Nov. 30, 1909. Physikal. Inst. d. Ignat. Coll., Valkenberg, July, 1909.)—A definition of capacity is given which can be applied to the case in which the capacity varies with the motion of some part of the system of conductors; and a general theory of electrostatic measuring instruments is developed by the aid of the Lagrange-D'Alembert principle. The theory is then applied to the quadrant electrometer used heterostatically or idiostatically, and the change of the capacity factors with deflection is determined experimentally. [See also Abstracts Nos. 159 (1904) and 1305 (1906).]

G. E. A.

165. Magnetic Survey Yacht "Carnegie." (Terrestrial Magnetism, 14, pp. 57-66, June, 1909.)—A description of the vessel in the construction of which no iron is used. **J. Craig, Jr.** (Ibid. pp. 131-135, Sept., 1909.)—Describes the non-magnetic gas engine fitted on board.

166. Magnetic Observations in Central Africa. **Audouin.** (Comptes Rendus, 149, pp. 878-880, Nov. 15, 1909.)—Results are given of the first determinations of the magnetic elements in Dahomey, and from the Niger to Lake Tchad, made by the Tilho mission.

A. D. R.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

187. *Atomic Weight of Radium Emanation.* F. Soddy. (Nature, 82, p. 188, Dec. 16, 1909.)—It has been shown for the heavier monatomic gases, neon and argon, that the experimental conductivity agrees fairly well with that calculated from the kinetic theory from the number of impacts of the molecules per cm.² per sec., and the molecular heat of the gas, assuming perfect interchange of energy on impact. This suggests a possible means of obtaining experimental evidence on the much-debated question of the atomic weight of RaEm. The thermal conductivities of the heavier monatomic gases should be inversely proportional to the square root of their atomic weights, so that the atomic weight of RaEm could be compared with those of the heavier argon gases by a novel method. A. E. G.

188. *Changes in Colour of Diamonds under the Action of Röntgen and Kathode Rays.* P. Sacerdote. (Comptes Rendus, 149, pp. 993-994, Nov. 29, 1909.)—From an investigation of the successive action of Röntgen rays, kathode rays, and a temperature of 300-400° C. upon diamonds, either colourless, or having a faintly greenish yellow tinge, it is concluded that whilst Röntgen rays do not sensibly alter their colour, this is considerably changed by kathode rays, becoming first a Madeira-wine tint, and then a more or less deep brown, which is permanent, even in direct sunlight. The original colour of the diamond is restored by heating it to 300-400° C. [see also Abstracts Nos. 2117 (1907), 985 (1908)]. A. Meyère. (Ibid. pp. 994-995, Nov. 29, 1909.)—Corundum, white, rose, or blue, and diamonds, when subjected to the action of radium, Röntgen rays, or kathode rays (whatever the nature of the electrodes), always assume a more or less deep yellow colour. Contrary to original expectation, this is not due to the projection of some element into the stones. W. H. St.

189. *Production of Ozone by Ultra-violet Light.* E. van Aubel. (Comptes Rendus, 149, pp. 983-985, Nov. 29, 1909.)—That ultra-violet radiations produce ozone had been observed by Lenard in 1900, confirmed by Goldstein, Regener, F. Fischer, and F. Braehmer [see Abstract No. 2129 (1905)], but recently denied by H. Bordier and T. Nogier, who described the smell of ozone noticed near a quartz-mercury lamp as purely subjective. F. Fischer, had therefore repeated his experiments with the same result. The author takes an A.E.G. quartz mercury lamp, provides it with a glass globe, and places in the globe cups containing olive oil, petroleum, or distilled water. The oils were discoloured and liberated iodine, and the water showed photographic effects. The author does not dwell on the interpretation of these reactions which, after all, would not really prove the presence of ozone. H. B.

170. *Mechanism of Adsorption ("Sorption") of Hydrogen by Carbon.* J. W. McBain. (Phil. Mag. 18, pp. 916-935, Dec., 1909.)—The taking up of gases by charcoal has been assigned by various investigators to the formation of solid solution or surface condensation—absorption or adsorption. The author recommends the term "sorption," and shows by experiment that the process is of a dual nature. There is first of all a surface adsorption which

face film, but the latter is formed, although in less degree, in absence of evaporation. Alcoholic solutions behave like aqueous solutions with fresh films, the former being crystalloid and the latter colloid, in character. In agreement with these views, it is found that electrolytes hasten both the formation of surface film and the increase of the electrical light-effect, the acceleration increasing with the concentration of the electrolyte; non-electrolytes are without influence. Inorganic colloids, like arsenic and antimony trisulphides, which in the solid state show Hallwachs' effect and in colloidal aqueous solutions form surface films, exhibit behaviour similar to that of the organic dyes, the phenomenon of film-formation being due to the colloidal nature of the solutions. Film-formation does not always proceed parallel with light-effect. T. H. P.

173. *Recovery of Volatile Solvents from the Air.* G. Claude. (Comptes Rendus, 149. pp. 780-782, Nov. 8, 1909.)—The enormous amounts of alcohol and ether wasted in the manufacture of artificial silk, celluloid, smokeless powders, &c., can hardly be recovered by chemical means, but the author has succeeded by applying refrigeration combined with compression. The water-vapour would cause serious trouble if it were not condensed together with some alcohol and ether which prevent freezing of the water. The air is compressed to 4 atmos., cooled by means of water, and passed through a system of tubes, in which the rising air is exposed to lower and lower temperatures. At the top the temperature is -90°C .; all the vapours will have condensed, and the air is allowed to expand; this expansion provides the required cold. Power has thus to be supplied chiefly for compression. In experiments conducted for the Administration des Poudres et Salpêtres, the author has treated more than 20 m.³ of air per h.p.-hour and recovered 0.9 of the alcohol, although the air contained sometimes only 0.5 gm. of alcohol per m.³. With ether vapours of the same percentage, more than 800 gm. of ether could be recovered per h.p.-hour. H. B.

174. "Pinch-effect" in Electric Induction Furnaces. J. Harden. (Electrochem. Ind., N.Y. 7. pp. 478-480, Nov., 1909.)—Gives practical figures relating to the "pinch-effect," obtained in a 60-kw. induction furnace of the Kjellin type. This effect was observed when melting scrap and pig-iron preparatory to a steel-melting test. The approximate section of the bath was, when the phenomenon occurred, width $1\frac{1}{2}$ in.; depth $2\frac{1}{2}$ in.; hence, cross-section 4.875 sq. in. The bath was nearly rectangular, the bottom being somewhat narrower than the top. The metal contained 2 per cent. of carbon, and the temperature was about 1400°C . The current density was about 1020 amps. per sq. in. The level of the bath began to recede at a certain point, showing a cavity about $\frac{1}{2}$ in. deep. As this occurred on several occasions at the same spot the lining was examined, and it was found that a small piece of cinder, fused to the wall of the lining, caused a slight distortion of the bath section on this spot. As the temperature rose to a bright white-heat, the agitation became more violent; until a complete rupture took place, followed by a loud report and a severe shaking of the furnace body. A strong flash was observed and the level of the metal rose to about $1\frac{1}{2}$ in. above the average on both sides of the rupture, and the metal rushed down these hills with great rapidity. The bath closed immediately after the rupture, but as soon as the surfaces were touching they were again separated before full contact was obtained. If allowed to go on, the metal soon froze, owing to the oxidation caused by the flashing. This annoying feature could

be avoided in the case of iron melting by lowering the power as soon as the first tendency to recess is noticed and by throwing into the cavity small pieces of pig-iron of about the size of a pea. When the bath was filled to its normal depth of about 6 in., it was not possible to obtain the "pinch-effect" with the total power available—68 kw. The general agitation of the bath due to the combined effect of the heat and the magnetic influence is considered in detail, and three classes of rotation are described, viz.: (1) A rolling motion due to the rotation of the mass of metal round the longitudinal axis of the bath; (2) the throwing of the metal towards the outer wall of the hearth, causing the level on the outer circumference of the bath to rise, sometimes 8 to 10 per cent.; (3) the rotation of the molten ring around the primary coil. The pinch-effect was further observed when dealing with copper and brass. The melting of the former was entirely frustrated in an ordinary magnesite lining. It was quite possible to keep brass molten, but the pinch-effect was readily obtained when the current was forced. The zinc fumes which were liberated when the rupture took place caused some difficulty in re-establishing good contact; by throwing in small pieces of scrap brass and slightly lowering the current, the pinch-effect could be tolerably avoided. In a larger induction furnace, with a charge of 2 to 3 tons, the pinch-effect is very rarely observed, except if the melting is very much forced. In the case of the combined furnace of the Röschling-Rodenhauser type the pinch-effect does not seem to have been observed in regular operation. [See also Abstract No. 1773 (1909).]

175. *Thorium*. H. v. Wartenberg. (Zeitschr. Elektrochem. 15. pp. 866-872, Nov. 15, 1909. Physikal.-chem. Inst. d. Univ., Berlin.)—The author prepares thorium chloride, ThCl_4 , according to Matignon and Bourion by passing chlorine over ThO_2 , and throws the chloride into a fused mixture of NaCl and KCl . The cell consists of an anode crucible and a cathode rod, both of Acheson graphite, placed in a porcelain crucible which is heated up to 800° ; 25 gm. of ThCl_4 yielded with currents of 4 amps. about 10 gm. of grainy metal in 4 hours. The method is that of Moissan and Hönigschmid, who used a porcelain crucible, however, which was rapidly destroyed by the thorium chloride above 750° . The resulting metallic Th still contained 11.6 per cent. of ThO_2 , in addition to small quantities of Fe, Na, C, but was ductile and melted at 1690° C. or higher; according to W. v. Bolton, who erroneously believed he was in accord with Hönigschmid, the melting-point should be 1450° C. H. B.

176. *Preparation of Vanadium and other Metals by the Thermit Method*. W. Prandtl and B. Bleyer. (Zeitschr. Anorg. Chem. 64. 8. pp. 217-224, Oct. 30, 1909. Laborat. f. angew. Chemie a. d. kgl. Univ., München, June, 1909.)—Confirming the experiences of Goldschmidt and others, the authors have found difficulty in obtaining pure vanadium by reducing V_2O_5 with Al. Calcium alone could not be applied on account of the high melting-point of its oxide, and the addition of fluorspar or cryolite was not effective. Since vanadium has a great affinity for Si, reduction of V_2O_5 with Ca-Si mixtures gave very impure metal. Ultimately a mixture of Ca and Al was adopted for the reduction of V_2O_5 , prepared by igniting ammonium metavanadate. A mixture of 8 atoms Ca and 2 atoms Al was found to give the most satisfactory results, and the heat generated was sufficient to re-melt the roughly powdered vanadium with its adhering slag, obtained from previous reactions. Such an addition, even in considerable quantities, does not appear to materially hinder

the reaction, and when working on large quantities the yield was increased by this means. The vanadium is obtained as a crystalline regulus containing about 94 per cent. V. It is hard enough to scratch quartz, but is not easily broken with a hammer. When polished it retains a bright surface for a long time. On account of its great affinity for oxygen, Si, and carbon, it cannot be purified by fusion, and has not been obtained purer than 94.5 per cent. V. Manganese, Cr, Fe, Co, and Ni have been obtained by similar methods, but Ti, W, and Mo have been obtained only in the form of small scales and shot. **R. Vogel and G. Tammann.** (Ibid. p. 225, Oct. 30, 1909.)—Vogel and Tammann criticise the work of Prandtl and Bleyer, and uphold the view that reduction of V_2O_5 with Al is the best method of obtaining pure vanadium [see Abstract No. 1185 (1908)]. By this means vanadium of 99 per cent. purity can be obtained as against 94 per cent. obtained by reduction with a Ca-Al mixture. Both in the reduction of Cr_2O_3 and V_2O_5 with Al the reaction sometimes fails, and while the difficulty in the case of Cr can be overcome by the addition of a little $K_2Cr_2O_7$, such a method is not yet available in the case of vanadium. **F. C. A. H. L.**

177. *Some Zinc Alloys.* **B. E. Curry.** (Journ. Phys. Chem. 13, pp. 589–605, Nov., 1909.)—*Antimony-Zinc.*—Gives an equilibrium diagram from observations made on heating-curves by the use of annealed ingots. The diagram contains only one maximum, ZnSb, and two eutectics, one at 22 and the other at 97.5 per cent. Zn; it consists of six phases—pure Sb, pure Zn, the compound ZnSb, and three series of solid solutions, α , β , and γ . The α and β phases are unstable below 487° and 405° respectively, and the γ phase is stable only below the solidus. The alloys from 0–85 per cent. Zn show but two absorptions on heating-curves; these occur at the liquidus and at the eutectic temperature 505°. The alloys from 85–45 per cent. Zn show four breaks on the heating curves; these represent two inversions—the solidus and the liquidus. From 45 to 95 per cent. Zn the alloys also show four similar breaks. From 95–97.5 per cent. Zn, β crystals separate from the melt and over this range three breaks occur in the heating-curves. From 97.5 per cent. Zn to pure zinc the heating-curves show breaks only at the solidus and liquidus. [See Abstracts Nos. 647 (1905) 1474 (1906).] *Zinc-Tin.*—The results obtained by Heycock and Neville are given. Microscopically all the alloys containing 99 to 7 per cent. Zn are not homogeneous, whether chill-cast or annealed. The ingot containing 99 per cent. shows the characteristic zinc structure, with traces of a second phase between the large crystals. This structure was not broken down by annealing at 180° for 1½ months. All the alloys containing 5 per cent. and less of Zn are homogeneous under the microscope, whether chill-cast or annealed. After annealing at 180° the 7 per cent. ingot becomes homogeneous. *Zinc-Cadmium.*—Microscopically all the alloys between 5 and 96 per cent. Zn are non-homogeneous. This field widens upon annealing, and at 217° the 5 per cent. ingot is homogeneous although the 6 per cent. ingot is not. The eutectic can be traced to about 96 per cent. Cd and 97 per cent. Zn. *Zinc-Lead and Zinc-Bismuth.*—Castings of varying concentration were made and annealed. It is certain from the microscopical examination of Zn-Pb alloys that pure Zn separates from Zn-rich melt, and from the nearness of the eutectic concentration to pure Pb, it is certain that pure Pb separates from a Pb-rich melt. The Zn-Bi alloys are similar to the Zn-Pb; pure Zn crystals separate from the Zn-rich melt, whilst from the Bi-rich melt crystals containing 4 per cent. of Zn in solution, crystallise out. **C. O. B.**

178. Magnesium-Aurides. G. G. Urasow. (Polytechn. Inst. St. Petersburg, Ber. 11. 1909. Zeitschr. Anorg. Chem. 64. 4. pp. 875-896, Nov. 17, 1909.)—The solution of gold in molten Mg is accompanied by a reaction of sufficient violence to cause spitting, and accordingly, an alloy corresponding to the formula AuMg was first made in a closed crucible. This alloy was used as a starting-point for the remainder of the alloys, since it dissolves readily in Au or Mg, and to prevent oxidation the alloys were melted under a layer of NaCl, KCl, or BaCl₂, the composition of the whole of the alloys being checked by chemical analysis. Cooling curves were taken by aid of the Kurnakow registering pyrometer, and the results collected in the form of an equilibrium diagram; this shows three maxima, at 818, 788, and 1,150° C., corresponding to the compounds Mg₃Au, Mg₂Au, and MgAu respectively. A fourth compound, β Mg₃Au, is formed at 796° C. by the reaction of Mg₃Au with the mother-alloy; at lower temperatures the β Mg₃Au, is converted into α Mg₃Au, with evolution of heat. The Mg—Mg₃Au eutectic contains 6.96 atoms per cent. Au and separates at 575° C., the Mg₃Au—Mg₃Au eutectic contains 81 atoms per cent. Au and separates at 776° C., the Mg₃Au—MgAu eutectic 86.4 atoms per cent. Au and separates at 780° C., while the MgAu—Au eutectic contains 67.5 atoms per cent. Au and separates at 827° C. No solid solutions are formed at the Mg end of the series, but the Au end is characterised by a tendency towards the formation of solid solutions of high concentration, the range of insolubility in the solid lying between the narrow limits 67.5 and 71 atoms per cent. Au. The paper is illustrated by twelve photomicrographs, examination of which confirms the results of the cooling curves. F. C. A. H. L.

179. Manganese-Aluminium-Copper. F. Heusler and F. Richarz. (Zeitschr. Anorg. Chem. 65. 1. pp. 110-112, Dec. 4, 1909.)—The authors criticise the paper by Ross and Gray [see Abstract No. 1808 (1909)], and consider that the English workers are not sufficiently familiar with the work of Heusler and his collaborators on the magnetic properties of thermally-treated Mn-Al bronzes. Working on forged bronzes Heusler and his pupils have shown: (1) That these bronzes become unmagnetisable when quenched from above 200° C. "Ageing" at 110°-150° C. confers a max. magnetisability with a minimum of hysteresis. (2) When cooled slowly from above 200° C. these bronzes become strongly magnetic, but show a very high hysteresis. Ross and Gray have subsequently confirmed these results by working on cast bronzes of somewhat different composition. In cast bronzes the conditions are somewhat more complex than in the case of forged material, so that Heusler's rule for forged bronzes, viz., "The hysteresis will be higher, the slower the rate of cooling through the inversion temperature," may not be strictly applicable to cast bronzes. F. C. A. H. L.

180. Malleable Cast Iron. R. Namias. (Engineering, 88. p. 669, Nov. 12, 1909. Translation in abstract of paper read before the Internat. Congress of Applied Chemistry, May 29, 1909.)—Considers the composition of cast iron suitable for making malleable castings, and states that proof that the chemical action taking place is great is afforded by the more marked effect on small castings. Gives examples of various oxidising agents used for the process, and analyses of treated metal, showing the action on the C, S, P, &c., in the iron. A mixture of ferric oxide and silica sand, which is often used, has the disadvantageous property of partly scarifying the iron oxide, forming a porous mass which frequently produces an extensive corrosion of the surface.

It was found that a substitution of lime for the silica slightly increased the fining power of the compound, and also that the heat-treatment could be carried further. Experiments have shown, however, that a mixture of small iron refuse and forge-scale, containing some free metallic iron, gave the best results so far as the preservation of the outside surface of the casting is concerned. Another mixture is described, consisting of iron oxide, graphite, and magnesia, which has been used by the author, with results similar to those obtained by the last-mentioned mixture. The object of the graphite was to greatly increase the amount of CO_2 formed during the process, in order that the action may be more effective and should reach deeper down below the surface. C. O. B.

181. *Law of Fixed Pressures of Dissociation.* H. le Chatelier. (Comptes Rendus, 149. pp. 250-254, July 26, 1909.)—Attention is directed to the fact that although the law of fixed vapour-pressure for liquids has been verified accurately by experiment, the corresponding law of fixed dissociation pressures of solids such as chalk is practically unsupported by experiment, the values obtained by various observers being very far from constant, e.g., there is an uncertainty of 100° as to the temperature at which the dissociation-pressure of chalk is equal to 1 atmo. These irregularities are attributed to the porosity of the dissociating solid, which may, like charcoal, condense large volumes of gas by "adsorption" in the pores. This difficulty may be got over by working in presence of a solvent. Thus in the case of chalk, it is suggested that the porosity might be removed by working in presence of a mixture of carbonates melting at about 600° ; this would be saturated with lime and with chalk, and the pressure of carbonic anhydride in equilibrium with the melt would be identical with the normal dissociation pressure of chalk. For the dissociation of slaked lime a mixture of sodium and potassium hydroxides might be used, and for the dissociation of hydrated salts a solution of some deliquescent salt or acid. Under these conditions, it is suggested, the law of fixed dissociation pressures might hold good rigidly. T. M. L.

182. *Theory of Electrolytic Ions. II. Electrolytic Dissociation of Water.* R. Lorenz and A. Böhi. (Zeitschr. Phys. Chem. 66. 6. pp. 733-751, June 8, 1909; Physikal. Chem. u. Elektrochem. Laborat. am eidg. Polytechnikum, Zürich.)—By means of measurements of the e.m.f. of an acid and alkali cell the following values were deduced for the concentrations of the ions in water, the values obtained by other observers being shown in the later columns of the table:—

t.	e.m.f.	C $\times 10^7$.	Kohlrausch and Heydweiller.		Noyes.	Lundén.
			0.36	0.34		
0°	0.6469	0.37	0.80	0.77	0.68	—
18	0.6531	0.85	1.05	1.02	0.91	1.02
25	0.6560	1.10	—	—	—	—
30	0.6581	1.22	—	—	—	—
40	0.6620	1.36	—	—	—	1.72
50	0.6671	2.06	2.48	2.38	2.12	2.27
60	0.6736	3.55	—	—	—	—
70	0.6803	4.61	—	—	—	—
80	0.6862	5.92	—	—	—	—
90	0.6940	7.30	—	—	—	—
100	0.7020	8.49	—	—	—	—

T. M. L.

183. *External P.D. between a Metal and Solutions of its Salts.* G. Guglielmo. (Accad. Lincei, Atti, 18. pp. 850-858, Nov. 7, 1909.)—Employing a Kelvin water-dropping electrostatic apparatus and a Dolezalek or Mascart

electrometer, the author has measured the external p.d. in the air between the various parts of an ordinary Daniell cell and of a similar cell with chlorides of Zn and Cu instead of the respective sulphates. It is concluded that the external p.d. is not a reliable indication of the internal p.d., the former remaining practically unchanged by amalgamation of the Zn, whilst the latter is considerably reduced. The following are the results obtained:—

$V(\text{ZnCl}_2)$	— $V(\text{Zn})$	= 0.56
V	— $V(\text{Zn amalgamated})$	= 0.088
$V(\text{ZnSO}_4)$	— "	= 0.097
$V(\text{CuCl}_2)$	— $V(\text{Cu unpolished})$	= 0.111
"	— $V(\text{Cu polished})$	= 0.070
"	— $V(\text{Cu electrolytic})$	= 0.062
$V(\text{CuSO}_4)$	— $V(\text{Cu electrolytic})$	= 0.074

For the complete cell the results are—

Cu	Zn	ZnCl_2	CuCl_2	Cu
0	0.94	1.04	1.04	0.98

(whilst direct measurement of the p.d. between the two poles gave 1.01 volt. In Helmholtz's formula $V = C/e \times T \cdot \partial V/\partial T$, where V = p.d. and C the heat which will, in the absence of any current, produce the same chemical effect as that caused by the passage of the quantity of electricity z , the term $T \cdot \partial V/\partial T$, for a Daniell cell appears to be very small, and may possibly be neglected, though further experiments are being made to confirm this.

184. *A New Platinum Oxide.* L. Wöhler [experimental work by F. Martin]. (Zeitschr. Elektrochem. 15, pp. 769-778, Oct. 15, 1909. Paper read before the 16th Hauptversamml. d. Deutsch. Bunsen-Gesell., May, 1909.)—Whilst iridium and the other platinum metals yield higher oxides, when their dioxides are fused with alkali, the highest platinum oxide known was PtO_5 . The authors succeed in obtaining a higher oxide by electrolysis a solution of dioxide hydrate in caustic potash by a current at 85 volts in a diaphragm cell with Pt electrodes.

185. *Electrolytic Formation of Silver Mirrors.* R. Lohnstein. (Phys. Zeitschr. 10, pp. 672-678, Oct. 1, 1909.)—If a p.d. of a few volts be applied to two silver electrodes immersed in distilled water a slight current passes leading to the formation of a solution of silver hydroxide; part of the spongy silver separating at the kathode spreads over the surface of the liquid as a shining film, and in some cases small silver mirrors form on the walls of the vessel in the neighbourhood of the electrodes. If a sugar, glycerol, gelatine, or Rochelle salt is dissolved in the water the mirror formation is increased, the most regular mirror being obtained by the electrolysis of 2-8 per cent. cane-sugar solution. Such small proportions as 1/100-1/800 per cent. of ammonia, potassium hydroxide, and Rochelle salt favour the formation of mirrors. Another metal, such as Pt or Cu, may be employed in place of silver as kathode.

186. *Electrolytic Oxidation of Alcohol to Acetic Acid.* P. Askenasy, R. Leiser, and N. Grünstein. (Zeitschr. Elektrochem. 15, pp. 846-860, Nov. 1, 1909. Inst. f. Physikal. Chemie u. Elektrochemie d. techn. Hochschule, Karlsruhe.)—The authors describe the electrolytic preparation of

acetic acid from alcohol, both commercial spirit and fermented beet-root sap. The electrodes are sheets of Pt-wire gauze, placed over a frame, formed by bending a glass rod of 3 mm. thickness to a rectangle. The applied e.m.f. was generally 4.5 volts, the current density 22 amps./dm.². The electrolyte consisted, in the first series, of about 190 gm. of absolute alcohol and from 25 to 87 gm. of sulphuric acid, diluted to 750 c.cm. The fermented crude beet-root sap used in the second series contained 8 per cent. of alcohol and further cane-sugar, albuminoids, salts, &c.; it frothed considerably during the electrolysis unless previously purified. This sap could not be so strongly acidified; the conductivity and current density were hence smaller, and the current-yield likewise. After adding chromium sulphate the yield rose to 61 per cent., however, while more than 80 per cent. had been realised in the first series. The electrolytes in both cases yielded also a little aldehyde and ester; after neutralising with soda, nothing but acetate and sulphate were found. The technical chances of this process are discussed and pronounced favourable.

H. B.

187. *Electro-analysis of Mercury Compounds with a Gold Kathode.* F. M. Perkin. (Faraday Soc., Trans. 5. pp. 45-48; Discussion, p. 48, Sept., 1909.)

—The electro-analyses were made with purified mercuric chloride and also mercuric bromide and sulphate. The electrolytes employed were nitric acid, sulphuric acid, hydrochloric acid, potassium cyanide, and sodium sulphide. The results were uniformly too high—from 0.5 to 1 per cent. This was not due to occluded hydrogen, nor could the increase in weight be due to oxidation. The author consequently pointed out that a gold electrode could not be satisfactorily used for analytical purposes. A rotating silver electrode showed similar results. The author finds that the best electrode for depositing Hg is one of mercury, the deposition being extremely rapid if a rotating anode is used. Two new quartz vessels are described for depositing Hg or other metals upon a mercury kathode.

T. S. P.

188. *Conditions determining Composition of Electro-deposited Alloys.* S. Field. (Faraday Soc., Trans. 5. pp. 172-194; Discussion, pp. 194-196, Sept., 1909. Electrician, 63. pp. 682-688, July 30, 1909. Abstract.)—In order to

trace the effect of varying conditions on the composition of electro-deposited alloys, the composition of brass, deposited from a cyanide solution, obtained under different conditions of (a) composition of solution, (b) strength of solution, (c) temperature, (d) current density, and (e) presence of free cyanide, was obtained by determining gravimetrically the percentage of Cu. The conditions for quantitative deposition from cyanide solutions of the metals separately were first determined, and the solutions were then mixed. So long as the deposition proceeds quantitatively and no hydrogen is evolved, the composition of the alloy may be approximately determined from its

mass by means of the formula: Percentage of Cu = $\frac{206}{a} (a - 1.028)$, where a = (weight of brass deposited) / (weight of Cu deposited in a voltameter in series). If the deposition proceeds quantitatively, without evolution of hydrogen, the share of the current required for the deposition of each metal can be obtained from its weight in the deposit. In the absence of hydrogen these shares, expressed as percentages, should equal 100, and thus an approximate check on the quantitative results could be kept. It was found that with a solution containing about equal quantities of the two salts in the

absence of any notable amount of free cyanide—(1) Cu is more readily deposited, and (2) the percentage of Zn increases with the current density, and also with the concentration of the zinc compound in solution. (3) Even with a large excess of the zinc compound, deposits containing a fair proportion of copper are readily obtained. (4) The effect of dilution is to raise the percentage of Zn on account of the higher e.m.f. necessary to maintain the same current density. (5) A rise of temperature induces the deposition of a larger proportion of Cu. (6) With appreciable amounts of free cyanide the percentage of Cu is always high, even with high current-density. Uniform deposition is not maintained in the cold stationary solution, and the insoluble cyanides formed at the anodes may completely insulate the plates. Uniformity may, however, be obtained without the presence of free KCN in notable quantity by using a warm and moving solution, the anodes dissolving freely under these conditions without the use of cyanide. T. S. P.

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189. *New Proof of the Existence of Molecules.* II. T. Svedberg. (Zeitschr. Phys. Chem. 66. 6. pp. 752-758, June 8, 1909. Chem. Universitätslaborat. Upsala, March, 1909.)—Experiments are described on the hydrolysis of ferric chloride, the precipitation of arsenic by H_2S , and the production of colloidal gold solutions. [See Abstract No. 1769 (1909).] T. M. L.
190. *Absorption of Nitrogen and Oxygen in Water and in Sea-Water.* C. J. J. Fox. (Faraday Soc., Trans. 5. pp. 68-86; Discussion, p. 87, Sept., 1909.)
191. *Velocity of Molecular and Chemical Reactions in Heterogeneous Systems.* M. Wildermann. (Phil. Mag. 18. pp. 538-577, Oct., 1909. Zeitschr. Phys. Chem. 66. 4. pp. 445-495, May 21, 1909.)—The author claims to have proved, "both theoretically and experimentally, that the explanation of his equation for molecular reactions in the case of solution of salts as a diffusion equation, and all the fundamental assumptions connected with the diffusion conceptions of Nernst, Brunner, and others, have no theoretical and no experimental support whatever." T. M. L.
192. *Vapour-pressure of Liquid Mixtures. New Demonstration and Generalisation of the Formula of Duhem-Margules.* L. Gay. (Comptes Rendus, 149. pp. 670-672, Oct. 26, 1909.)
193. *Electrical Hardening Furnace.* E. Sabersky and E. Adler. (Faraday Soc., Trans. 5. pp. 15-27; Discussion, pp. 28-36, Sept., 1909.)—Includes a comparison of operating costs for a gas furnace and an electric furnace.
194. *Constitution Diagrams of Tin with Sulphur, Selenium, and Tellurium.* W. Biltz and W. Mecklenburg. (Zeitschr. Anorg. Chem. 64. 3. pp. 226-235, Oct. 30, 1909. Chem. Laborat. der Bergakademie, Clausthal.)—These three series have been investigated by means of cooling-curves and microstructures, fusions being carried out in nitrogen atmospheres.
195. *Formation of Silicon Sulphide in the Desulphurisation of Iron.* W. Fielding. (Faraday Soc., Trans. 5. pp. 110-111; Discussion, p. 112, Sept., 1909.)—An investigation of the reaction between ferro-silicon and ferrous sulphide.

196. *Transformations of Selenium.* M. Coste. (Comptes Rendus, 149, pp. 674-675, Oct. 26, 1909.)—An account of observations made by the "change of volume" method.

197. *Electrical Conductivity and Viscosity of Concentrated Solutions of Orthophosphoric Acid.* A. Smith and A. W. C. Menzies. (Amer. Chem. Soc., Journ. 31, pp. 1191-1194, Nov., 1909.)—In spite of the existence of two hydrates in the region from 90 to 100 per cent. H_3PO_4 no irregularities could be detected either in the electrical conductivity or in the viscosity of the solutions: in this respect there is a marked contrast with the behaviour of sulphuric acid. T. M. L.

198. *Conductivity in Solutions of Meta- and Ortho-phosphoric Acids.* E. B. R. Prideaux. (Faraday Soc., Trans. 5, pp. 37-44, Sept., 1909.)

199. *Solid State.* III. J. J. van Laar. (Konink. Akad. Wetensch. Amsterdam, Proc. 12, pp. 120-132, Aug. 31, 1909.)—The author has calculated, by means of assumed values for a , b , &c. [compare Abstracts Nos. 1788, 1789 (1909)], and expressed as curves the isotherms for the absolute temperatures 9, 100, 128, 144, 160, 200, and 400. The separate isotherms and the relations between them are discussed. T. H. P.

200. *Kinetic Interpretation of Osmotic Pressure.* M. M. Garver. (Journ. Phys. Chem. 13, pp. 679-690, Dec., 1909.)

201. *Influence of Pressure on Miscibility of Two Liquids.* J. Timmermans and P. Kohnstamm. (Konink. Akad. Wetensch. Amsterdam, Proc. 12, pp. 234-244, Oct. 28, 1909.)—The authors discuss the different possible forms of the saturation curve of a binary mixture on which two liquid phases are in equilibrium [compare Abstracts Nos. 878 (1906)], 1237 (1907)]. Results are given of the measurements for a number of binary mixtures known to possess critical points of mixing within easily attainable limits of temperature, the shapes of the plait-point lines being discussed and classified for the cases where the region of miscibility (1) does and (2) does not extend into the region of the critical temperature for liquid-vapour. T. H. P.

202. *Theory of Solutions.* J. Holmes and P. J. Sageman. (Chem. Soc., Journ. 95, pp. 1919-1948, Nov., 1909.)—As a result of experiments on the volume-changes and heat-changes which take place on mixing various liquids the authors conclude that "physical forces only are operative in solution, and that theories requiring electrolytic dissociation or combination of solvent with solute are unnecessary for understanding many of the phenomena common to aqueous and non-aqueous solutions." T. M. L.

203. *Relative Rates of Migration of Ions in Aqueous Solution.* R. B. Denison. (Faraday Soc., Trans. 5, pp. 165-171, Sept., 1909.)—Deals with the transport-numbers of the chlorides and bromides of Na, K, NH_4 , Rb, Cs, Mg, Ca, Sr, and Ba.

204. *E.M.F. of certain Platinum Compounds.* P. E. Spielmann. (Faraday Soc., Trans. 5, pp. 88-101; Discussion, pp. 101-102, Sept., 1909.)—The subject is considered with special reference to the oxygen-hydrogen cell.

205. *Electromotive Behaviour of Cuprous Oxide and Cupric Hydroxide in Alkaline Electrolytes.* A. J. Allmand. (Chem. Soc., Journ. 95, pp. 2151-2167, Dec., 1909.)

206. *Electrolysis of Grape-sugar, Glycerine, and Glycol.* W. Löss. (Zeitschr. Elektrochem. 16, pp. 1-9, Jan. 1, 1910.)